SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

VOLUME 22

NUMBER 5

OCTOBER 1938

Science Education

Formerly GENERAL SCIENCE QUARTERLY

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

Volume 22 **OCTOBER, 1938** **Number 5**

Contents

(The Contents of SCIENCE EDUCATION are indexed in the Educational Index)

PUBLISHED BY

SCIENCE EDUCATION, INCORPORATED

Communications regarding manuscripts should be sent to the Editor, Science Education, 374 Broadway, Albany, N. Y., or 32 Washington Place, New York City. Major articles should be no longer than 3,000 words; classroom notes should be limited to 500 words. "Suggestions to Authors" will be sent upon request.

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Science Education

REPORT OF COMMITTEE ON SECONDARY SCHOOL SCIENCE OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

1. INTRODUCTION

This report is based on the findings of a questionnaire on practices and points of view in secondary school instruction covering grades seven to twelve inclusive. It was prepared by Ellsworth S. Obourn, John Burroughs School, St. Louis, Mo., and was submitted to about one hundred highly selected specialists in the field of secondary-school science teaching. This group included all members of the N.A.R.S.T., supplemented by a few selected curriculum specialists. The number of responses to the questionnaire was 79. These responses were carefully tabulated and the results of this tabulation are found in the summary which follows this introduction.

The questionnaire is made up of nine main divisions, each sub-divided into lesser items. The main divisions are: (I) General Philosophy, (II) Psychology of Learning, (III) Objectives of Secondary School Science, (IV) Criteria and Principles for the Selection of Content and Activities, (V) Organization of Content and Activities, (VI) Methods of Instruction, (VII) Evaluation of Learning Products, (VIII) Materials for Instruction, and (IX) Miscellaneous. The total questionnaire consists of 146 separate items.

The materials for the questionnaire were selected from several sources: books on the teaching of science, articles appearing in the literature of the field, and published and unpublished theses. In some instances the statements were taken directly from the source material and in others they were rephrased to meet better the purpose of the study. In cases where any changes were made, rewording was done carefully to avoid any wrong meaning or changed emphasis of the issue.

2. RATING THE QUESTIONNAIRE

Rating of the items was made on a five point scale. This scale ranged from 1, implying great importance, to 5, denoting unimportance. Complete disagreement with the issue was checked in the "X" column of the questionnaire. A "Y" column was used for checking if the checker did not understand the exact meaning of a statement.

There was considerable disagreement among the members of the committee as to the relative weighting of the "X" column and the place of the "Y" column in making weighted graphs. If we assume that the marking scale of 5 to 1 is based on the standard deviation of a normal probability curve, then there seems to be no statistical place for the "X" and "Y" columns. It was therefore thought best by the chairman to present the raw figures and to designate certain significant findings that would be unchanged by any weighted interpretation of the "X" and "Y" columns.

The findings represent strictly the opinions of competent specialists in the field of secondary-school science teaching with respect to better practices. It is in no sense an indication of what the majority of science teachers think should be better practices nor what they are doing in their classrooms. It should be used, therefore, purely as a starting point, or possibly a

check list in evaluating science teaching practices.

3. FINDINGS COMPARED WITH EARLIER STUDY

A comparison of these findings with an analysis of a study made by the chairman of the committee is interesting.[1] In this questionnaire answers came from over 350 representative junior- and senior-high schools in all parts of the United States. Although the junior-high-school teachers place much emphasis on exploratory experiences, the senior-high-school group do not rate this objective so high. Both groups rate high behavior adjustments toward the more practical aspects of life. Senior-high-school teachers are considerably more concerned than those from junior-high schools with abilities which will place emphasis on the phases of scientific thinking as well as on attitudes or traits which may be termed scientific. The power of interpretation is not considered so important as the power of observation by the junior-high-school group. The spirit of inquiry is stressed more in the junior-high school than in the senior-high school. In developing appreciations the place of natural law and the oneness of nature are rated highest although few teachers place great emphasis on any of the appreciations outlined in the committee's questionnaire. Under the acquisition of ideals and habits, the junior-high-school teachers stress interest in the further study of science, interest in nature, and in healthful living. This last group of habits also receives emphasis from the senior-high-school group. By far the greatest emphasis is placed by both groups on the acquisition of useful, general information and practical understandings which come from contacts with science, while the senior-high-school persons rate highest of all the propaedeutic function. These differences of opinion certainly ought to be taken into consideration, especially in relation to the teaching of science at the junior- as contrasted to teaching and learning at the senior-high-school level.

It is suggested by the Committee that a follow-up should be undertaken to determine what classroom teachers (rather than supervisors) think are good and bad practices and what they actually understand these practices to mean. Also an excellent study to follow this report would be an evaluation of the actual activities in the science classrooms to determine how they check with the teachers' ideas with respect to good practice and with the reports of the questionnaire as summarized.

4. PROBLEMS SUGGESTED

Some of the problems suggested by the questionnaire ought to be the object of widespread study. For example, we have no scientific way of arriving at valid objectives although many have been presented in the field of science at different grade levels. We need definite studies to determine the type of student activities which would bring about achievement of objectives at these different levels. More work is needed in the field of objective testing, especially tests on abilities to make reasonable generalizations from experimental data, in the planning of experiments, and in the application of scientific generalizations to new situations. We need studies in different environments to determine what grade placement of subject matter is best fitted for those environments. We need to know to what extent we can expect "scientific thinking" on the part of the lower I.Q.'s in our classes, and we need greatly to have experimental work done in our state controlled secondary schools as well as in the experimental schools connected with teachers' colleges, for the reason that the latter do not show true pictures of the cross sections of the clientele of the secondary schools in a democracy. The above are only a few of the studies

[1] Hunter, G. W., and Knapp, R. A. "Science Objectives at the Junior- and Senior-High-School Level," *Science Education*, 16: 407–416; October, 1932.

that ought to be made before we are in a position to determine what is best in science teaching at the secondary school level.

In the questionnaire and results that follow, the statements printed in bold faced type represent items which were weighted as 95 per cent or over, agreement by those answering, based on the five-point scale. The statements printed in italics had more than 10 per cent of those answering in complete disagreement with the issue. (But in this estimate no account could be taken of weighting, because these individuals were outside the weighted probability curve.)

QUESTIONNAIRE ON PRACTICES AND POINTS OF VIEW IN SECONDARY SCHOOL SCIENCE INSTRUCTION

	1	2	3	4	5	X	Y
I. GENERAL PHILOSOPHY							
1. Science in the secondary schools shall be considered as:							
1. An area of knowledge.	13	19	24	10	7	4	2
2. **A method of thought and procedure.**	46	20	5	3	3	1	0
3. An attitude of mind.	38	19	13	3	4	1	3
4. **A living experience.**	51	8	4	6	4	0	4
2. The implications of science in modern civilization demand that:							
1. More time shall be given to science in the secondary school.	35	11	15	5	6	3	2
2. **Secondary school science content shall be modified from present practice to include materials of greater social significance.**	45	11	13	4	2	0	0
3. **The methods of teaching should be markedly altered toward greater emphasis on attitudes of mind, methods of thinking and working, and the social implications of these aspects.**	54	15	6	0	3	0	1
3. Science can contribute to the orientation of students in all the basic relationships of life; for such contributions to be effective the science curriculum must be profoundly reorganized and the experiences of youth in this area must be widened.	38	17	11	5	3	0	3
4. **Secondary science is but one phase of a continuing process of education which begins early in life and continues for many through college. Hence there is need at all levels for constant integration and articulation, not only with the other aspects of science education, but with the other phases of general education.**	59	10	4	1	3	1	1
II. PSYCHOLOGY OF LEARNING							
Guiding principles for instruction in secondary school science suggested by modern psychology are:							
1. **Experience with natural phenomena and the applications of science shall lead to the formulation of conclusions related to those broad generalizations which have the largest application in human interests.**	48	17	6	0	3	0	3
2. **The problems and situations through which the learner attains the objectives sought shall duplicate as nearly as possible real life situations.**	56	10	8	2	2	0	0

	1	2	3	4	5	X	Y
3. **Motivation in learning is promoted by the understanding by the learner of the significance of the thing in which he is engaged and the satisfaction which it brings to him when completed.**	60	10	2	1	3	0	2
4. **A problem solving approach in secondary school science should be regarded as the best means of realizing outcomes of scientific methods and the understandings of the generalizations of science.**	50	15	6	1	3	1	2
5. **The applications of generalizations to new situations should be an integral part of the learning procedure.**	58	14	4	3	3	0	0
6. **The applications of methods used in problem solving in science should be made in new situations as an integral part of the learning procedure.**	48	12	9	1	4	1	2
III. OBJECTIVES OF SECONDARY SCHOOL SCIENCE							
Objectives include not only the ultimate and immediate, but also the general and specific.							
1. *The objectives for secondary school science shall be stated in terms of the big ideas or generalizations found in the writings of specialists in the various fields of science.*	16	10	12	14	4	13	3
2. The objectives for secondary school science shall be stated as behavior adjustments which the youth of today, as well as the adult, is called upon to make both in the intellectual and practical aspects of life.	36	15	6	4	5	6	7
3. An objective for secondary school science shall be to provide an exploratory experience which will be helpful:							
1. In the election of later courses in science.	14	18	26	8	6	1	0
2. In the selection of a vocation.	13	24	24	12	2	1	0
3. **In the acquisition of new fields of interest.**	32	26	14	2	1	1	0
4. **An objective of secondary school science shall be the mastery of those knowledges which are functional in aiding the individual to adjust himself in a more satisfying manner to the world about him.**	54	17	2	0	3	0	0
5. **An objective of secondary school science shall be to impart certain abilities to the student such as:**							
1. **Reliance on facts.**	48	17	3	6	3	1	0
2. **Power of interpretation.**	48	13	8	4	2	0	2
3. **Power of observation.**	47	14	6	4	2	0	3
4. **Ability to evaluate data.**	50	13	8	1	3	0	1
5. **Ability to think scientifically.**	60	8	1	2	3	0	1
6. **An objective of secondary school science shall be to develop certain scientific attitudes or traits in the learner such as:**							
1. **An objective attitude toward facts.**	60	8	2	3	3	0	0
2. **Freedom from dogma and superstition.**	61	8	2	3	3	0	0
3. **Tendency to hold conclusions as tentative and to suspend judgment until facts are secured.**	63	7	4	1	3	0	0

	1	2	3	4	5	X	Y
4. **Willingness to revise one's opinions if the evidence warrants.**	64	7	1	1	3	0	1
5. **To have a spirit of inquiry.**	64	11	3	1	3	0	1
6. **A conviction of the universality of the cause and effect relationship.**	55	10	4	3	4	2	1
7. An objective of secondary school science shall be to develop appreciations for such as the following:							
1. The contributions of the scientific mind.	30	26	12	3	3	0	2
2. **The contributions of science to mankind.**	39	25	8	1	3	0	1
3. The great men of science.	18	21	28	4	3	1	1
4. Expert judgment.	33	21	11	6	2	0	2
5. Nature.	33	14	11	5	3	1	6
6. One's responsibility in the world.	29	15	16	4	4	4	3
7. Natural law.	41	14	12	1	6	2	1
8. The importance of quantitative thinking.	24	17	19	3	6	3	4
9. Man's place in the universe.	32	23	14	3	4	0	2
10. Possible future developments in science.	19	25	21	6	2	0	1
8. An objective of secondary school science shall be to develop in pupils:							
1. An interest or desire for investigation in science.	18	25	20	10	3	0	1
2. An interest or desire for scientific reading.	26	30	15	5	2	0	1
3. An interest in pursuing the study of science further.	17	25	22	7	3	0	1
4. An interest in nature.	33	21	14	8	0	0	1
5. An interest in vocational fields.	11	25	25	7	5	2	1
9. *An objective of secondary school science shall be to assist pupils in the study of specialized fields in which they have become interested.*	19	18	18	13	4	13	0
10. *An objective of secondary school science shall be to train students for certain scientific vocations such as laboratory assistants and technicians.*	2	4	5	13	29	24	11
11. An objective of secondary school science shall be to train for the wise use of leisure time.	25	19	17	5	6	1	4
IV. CRITERIA AND PRINCIPLES FOR THE SELECTION OF CONTENT AND ACTIVITIES							
1. **Content for secondary school science shall be selected for the various levels with some reference to its difficulty.**	41	21	9	2	2	0	0
2. The selection of science content for the various levels of the secondary school shall be based upon valid studies of children's interests on those levels.	32	19	11	7	5	3	1
3. Science content for the various secondary school levels shall be selected on the basis of the findings of studies of life needs in modern society. (The consumer needs.)	32	22	12	7	4	1	1
4. Content for the levels of secondary school science shall be selected with reference to the possibility of organizing it into worthwhile problem situations.	15	33	12	8	2	4	2
5. Content for the science courses of the secondary school shall be selected with reference to its ability to contribute meaning and understanding to the major interpretative generalizations of science that have largest application in social relations.	39	16	11	4	2	2	4

	1	2	3	4	5	X	Y
6. Content shall be selected with special reference to the local environment.	10	28	23	9	5	1	1
7. Content shall be selected in part with reference to the findings of studies of the science found in the public press, current magazines, and commonly used textbooks in the various courses.	9	27	28	10	3	0	1
8. Selected content shall be practical and immediate rather than abstract and remote.	31	24	14	1	3	1	4
9. Learning experiences shall be selected with reference to the opportunities which they afford for making use of the various steps of the scientific method of solving problems.	34	21	9	4	5	2	3
10. **Learning experiences shall be selected with respect to their ability to build meaning and understanding for the elementary generalizations of science which have largest social implications.**	36	27	5	3	3	1	2
11. Content shall be selected with reference to its universality and probability of permanence in modern civilization.	13	29	12	11	2	3	4
12. Content shall be selected with reference to its ability to correct mistaken notions and superstitions.	32	23	10	6	3	0	1
13. *Content shall be selected on the basis of the judgment of laymen as to the value of certain principles and topics of science in modern life.*	5	13	30	13	8	8	0
14. **Learning activities shall be selected which offer opportunity for students of varying interests and capacities.**	58	9	8	1	3	0	0
15. **Content shall be so varied in its selection as to provide ample exploratory experience in the knowledge and methods of thought and procedure of the major fields of science.**	38	22	10	3	3	0	1
16. **Opportunities shall be provided which afford students the means of judging and measuring their progress toward the objectives sought.**	38	20	10	2	4	0	3
17. **Activities shall be selected which provide opportunity for the exercise of the creative abilities of youth and for the joy, romance, and adventure that discovery and invention in science afford.**	49	20	3	1	4	1	1
18. **In so far as possible, learning activities that call for direct, concrete, first-hand, experiences shall be selected.**	52	15	3	3	2	0	2
19. **The courses on the various levels of secondary school science shall consist of a series of physical and mental activities that shall lead to those knowledges, skills, interests, and attitudes essential to desirable mental and practical adjustments to the environment.**	51	12	5	3	3	0	3
V. ORGANIZATION OF CONTENT AND ACTIVITIES							
1. The content of secondary school science shall be organized around the major interpretive generalizations of science as found in the writings of the most competent interpreters of science.	22	14	21	5	3	7	3
2. The content of secondary school science shall be organized around worthwhile projects, initiated and carried through by the students.	15	17	25	6	5	6	0

	1	2	3	4	5	X	Y
3. *The content of secondary school science shall be organized around topics and sub-topics which have logical sequence with respect to the laws and principles of some specialized science.*	5	8	17	10	14	17	3
4. The content of secondary school science shall be organized around large units each representing some major aspect of the environment.	28	29	8	3	4	3	2
5. *The content of secondary school science in the junior high school shall be organized as an integrated part of a composite including other areas of knowledge on the same level such as Social Studies, Mathematics, etc.*	18	18	17	6	8	9	2
6. *The content of secondary school science in the senior high school shall be organized as an integrated course covering one or more years and made up from several sciences such as Physics, Chemistry, Geology, Astronomy, etc.*	24	18	9	3	7	11	3
7. The content of secondary school science shall be organized around a series of problems to insure adequate mastery of problem solving techniques.	27	15	12	7	7	7	1
8. **The major divisions (units, topics or problems) of the courses in secondary school science shall be so organized that the conceptions of science and their social implications, once learned, shall be used, if possible, in new relationships in some later division.**	45	20	4	2	2	1	2
9. **The content of the courses in secondary school science shall be so arranged as to enable students to apply generalizations in the solving of new problems and the interpretation of novel phenomena.**	41	26	1	3	2	2	0
10. The content of the courses in secondary school science shall be so organized as to develop a sequential story of man's understanding of, and adjustment to, his whole science environment.	18	22	16	7	4	7	3
11. The content of courses in secondary school science shall be so arranged as to call for the understanding of ever enlarging meanings, containing progressively difficult experiences and will continuously arrive at more and more comprehensive adjustments.	39	18	17	1	6	2	4
12. Content for secondary school science shall be organized in such a way as to make it a means to the solution of problems leading to major generalizations and not an end in itself.	34	20	11	1	3	4	3
13. The content of secondary school science shall be organized into units each of which leads to the understanding of, and the ability to apply, the understanding of some principle or process.	28	23	9	6	5	6	0
14. The objectives of secondary school science tend to determine the organization of content, but several types of organization may be consistent with a single objective.	48	11	7	0	5	3	3
15. **The organization of science content at all levels shall stress the unity of science and avoid the development of unnatural distinction between fields in the minds of students.**	49	15	7	3	2	1	0
16. The laboratory work for the specialized sciences of the senior high school shall be standardized for the most effective results.	7	8	6	8	12	31	3

	1	2	3	4	5	X	Y
VI. METHODS OF INSTRUCTION							
A. GENERAL CLASSROOM INSTRUCITON							
1. **Classroom methods in secondary school science shall recognize varying degrees of ability on the part of students.**	64	8	2	0	4	0	0
2. *The desirable outcomes of science instruction on the secondary school level are best achieved by the textbook-recitation method of instruction.*	3	0	7	9	19	35	2
3. **Methods of instruction in secondary school science shall provide the learner with many opportunities to exercise important abilities in problem solving such as:**							
1. **Inferring causes from observed effects.**	59	14	3	0	3	0	0
2. **Predicting effects from established causes.**	53	19	3	0	3	0	1
3. **Setting hypotheses on the basis of observed phenomena.**	47	15	8	2	5	1	0
4. **Analyzing data.**	48	20	4	2	4	0	1
5. **Testing hypotheses by experiment.**	48	18	3	2	5	1	1
6. **Reaching valid conclusions.**	60	10	3	1	3	0	1
7. **Applying learned principles and facts in new situations.**	58	14	1	1	3	0	1
4. Methods of instruction in secondary school science shall recognize the importance of overcoming student's reading and vocabulary difficulties.	42	21	6	3	2	1	3
5. Methods of instruction in secondary school science shall recognize the importance of wide reading in the establishment of scientific attitudes.	36	21	11	1	4	1	2
6. The unit plan of instruction embodying phases of the learning cycle such as initiatory activities, assimilative activities, culminating activities, and application activities, shall be used in developing mastery and understanding of principles on the various levels of secondary school science.	24	17	19	5	4	6	6
7. *Attainment of a scientific habit of thinking and working, and a scientific attitude of mind on the part of the learner shall be regarded as a concomitant outcome of general instruction, not to be sought for directly as outcomes through problem solving and other activities.*	15	16	3	4	6	28	5
8. The use of workbooks and guide sheets in secondary school science shall be regarded as an important factor in promoting effective learning.	17	16	18	14	4	6	1
9. **Science instruction on the various levels of the secondary school shall recognize motivation as an essential for learning and use devices to secure it in the classroom.**	50	16	1	3	3	2	2
10. The individual, or small group plan of instruction shall be used in presenting the science content on the various levels of the secondary school.	18	8	14	12	8	9	6
11. Many of the desirable outcomes of science instruction on the secondary school level are best achieved through the use of the lecture-demonstration method.	28	24	14	1	5	3	1
12. *The older recitation method of classroom activity shall be regarded as an effective practice in secondary school science teaching.*	4	3	12	15	18	19	6

	1	2	3	4	5	X	Y
13. The socialized recitation shall be regarded as an effective practice in secondary school science teaching.	20	22	15	10	4	3	2
14. Assignments for home preparation shall be regarded as effective in promoting learning in secondary school science.	15	14	19	16	9	3	1
15. Assignments for preparation in supervised study periods shall be regarded as effective practice in promoting learning in secondary school science.	26	25	13	8	4	0	1
16. **Excursions into the local community for purposes of illustrating applications of knowledge, or for purposes of first hand investigation, shall be regarded as effective in promoting learning in secondary school science.**	46	21	6	1	3	0	0
17. Extensive reading of non-technical material shall be regarded as an effective and worthwhile procedure for promoting learning in secondary school science.	32	26	9	1	6	1	2
B. LABORATORY INSTRUCTION							
1. **Laboratory work in secondary school science shall be designed to teach pupils how to observe, how to come to independent conclusions, on the basis of their own observations, and how to check their conclusions.**	52	12	5	2	3	1	0
2. Laboratory experiments shall be set for secondary school science courses which concern some worthwhile problem in the student's experience rather than being only a series of activities to illustrate the content of the course.	41	21	4	2	6	2	0
3. The notebook in which experiments are recorded shall be regarded as an important factor in promoting effective learning in secondary school science.	21	16	16	13	8	3	0
4. *Teachers of the various courses shall regard the demonstration method as the most effective in promoting learning in secondary school science.*	10	6	17	6	7	26	2
5. *Teachers of the various courses of secondary school science shall regard the laboratory method as the most effective in promoting learning.*	6	17	13	4	6	25	2
6. **Teachers of the various courses of secondary school science shall regard that in some types of experimental situations effective learning is best obtained through the demonstration method while in other situations the laboratory plan is superior.**	65	7	2	0	3	0	0
7. **Teachers in secondary school science shall devise ways and means of more closely correlating the laboratory and classroom work.**	59	9	4	2	2	1	0
8. Pupil demonstration shall be regarded as an effective procedure in promoting learning in secondary school science.	33	17	18	2	5	1	0
9. *Notebook drawings shall be regarded as important in promoting learning in secondary school science.*	9	13	19	14	11	8	0
10. The number of quantitative experiments in secondary school science should be reduced to a minimum and emphasis placed on those which are qualitative.	21	18	13	6	3	6	5

	1	2	3	4	5	X	Y
VII. EVALUATING LEARNING PRODUCTS							
1. The pre-test, used to discover the knowledge which a student brings to the study of a unit in science, shall be regarded as an effective device in diagnosing pupil's needs.	32	17	16	6	3	3	0
2. **Factual tests shall be regarded as important only when the facts are essential to the attainment of more important objectives of instruction.**	42	21	4	4	3	1	0
3. Tests for secondary school science should test the student's ability to do factual thinking.	23	18	14	6	6	2	5
4. **Tests for secondary school science shall evaluate the student's progress in understanding the elementary generalizations of science.**	44	20	6	2	3	1	1
5. **Test for secondary school science shall, if possible, evaluate the progress of students in developing various scientific attitudes such as:**							
1. **Openmindedness.**	57	7	5	2	4	1	1
2. **Tolerance.**	55	10	2	2	5	2	1
3. **Freedom from superstition and prejudice.**	55	8	5	1	4	2	1
4. **Willingness to change opinions in the light of new data.**	59	9	1	1	4	2	1
6. **Tests for secondary school science shall reveal the student's ability to infer causes from observed effects.**	47	16	6	4	5	0	0
7. **Tests for secondary school science shall reveal the student's ability to predict effects from a given set of established causes.**	42	20	5	3	8	0	0
8. **Tests for secondary school science shall reveal the student's ability to apply learned elements in new situations.**	55	14	4	0	3	0	1
9. Tests for secondary school science shall reveal the student's resourcefulness.	35	19	14	1	5	0	3
10. Tests for secondary school science shall reveal the student's ability to set up hypotheses on the basis of certain observations.	35	20	8	4	8	2	0
11. **Tests for secondary school science shall reveal the student's ability to draw valid conclusions from a given set of data.**	57	11	5	1	3	0	0
12. Tests for secondary school science shall reveal the student's progress in the ability to use certain laboratory techniques and skills.	12	21	19	11	11	1	0
VIII. MATERIALS FOR INSTRUCTION							
1. Equipment for instruction on the various levels of secondary school science shall be, in so far as possible, of the simple, practical, home-made type.	23	19	17	3	5	7	0
2. **Visual aids shall be regarded as valuable for vicarious experiences for the learning of secondary school science.**	49	15	9	1	2	1	0
3. **Visual aids are of distinct value in pre-view and culminating activities in the learning of various units of secondary school science.**	45	17	8	4	3	0	0
4. *For the teaching of courses in secondary school science it shall be regarded as sufficient to supply one complete set of experimental equipment to be used in teacher and pupil demonstrations.*	3	1	6	7	14	41	4

	1	2	3	4	5	X	Y
5. **For the teaching of courses in secondary school science it shall be regarded as essential to supply both equipment for teacher demonstration and also equipment for individual laboratory experimentation.**	50	7	9	4	2	3	2
6. *In small high schools, it shall be regarded as inconsistent with necessary economy to provide more than one or two rooms to be used by the science department.*	24	11	5	2	7	12	14
7. *For the large high schools it shall be regarded as desirable in the specialized science of the last three years of the secondary school, to separate the classroom from the laboratory.*	14	2	12	5	10	30	1
8. In line with the urge to correlate more closely classroom and laboratory work, it shall be regarded as desirable practice to have classroom layouts so designed as to permit all class activities to be carried out in a single room.	45	18	6	0	3	5	0
9. Radio instruction in secondary school science can be made an effective aid in the science program of the rural or isolated school.	23	16	11	9	1	5	6
10. *Radio instruction in secondary school science by a competent teacher is a desirable substitute for science as now taught in the average school.*	3	2	8	5	10	43	3
11. The science room shall be regarded as a place where the pupil may receive educative experiences which add meanings to and give better understandings of, those generalizations in science that contribute to enrichment of life.	56	12	2	0	3	2	3
12. A piece of equipment or apparatus shall be evaluated in terms of the educative experience or experiences which it makes possible.	53	16	1	1	3	0	2
IX. OTHER MISCELLANEOUS PROBLEMS OF SECONDARY SCHOOL SCIENCE							
1. The methods and materials of science instruction for the seventh, eighth, and ninth grades shall be the same regardless of the administrative organization of these levels. (8–4 or 6–6 plan.)	36	13	10	2	7	7	1
2. **Science instruction shall be arranged in a continuous and dependent sequence from the primary grades to the end of high school.**	53	10	4	2	3	2	1
3. *Secondary school science shall differentiate its science curricula to meet the needs of the college preparatory and non-college preparatory students.*	31	8	7	8	11	8	0

A careful analysis of answers to the above material indicates that for the most part the findings from the questionnaire are valid. There is little contradictory evidence shown in the answers and surprising unanimity of opinion on the more fundamental items.

It is hoped that the above report will serve as a basis for future work of the committee.

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A TECHNIQUE FOR APPRAISING CERTAIN OBSERVABLE BEHAVIOR OF CHILDREN IN SCIENCE IN ELEMENTARY SCHOOLS *

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INTRODUCTION

Great changes have taken place in the schools of the United States in recent years. These changes have affected practically all phases of education—the approach, methods, content, and administrative procedures.

These changes in education indicate signs of healthy growth in seeking to develop schools which will meet more nearly the needs of the individual and of society. In the light of these changes, it becomes the duty of educators to try to appraise the products of their efforts. The purpose of such appraisals is to determine the growth of individuals toward these new values which have been formulated as objectives of education. In view of recent trends, such growth may be appraised through the development of individual behavior patterns.

Administrators, teachers, parents, and others interested in the products of education are no longer content to make appraisals in terms of artificial marks, arbitrarily given, upon subject matter which has become traditionally associated with different phases of education. Subject matter is no longer looked upon as the end product of education; rather it has come to be thought of as a means to an end. This is shown by an examination of modified systems which are being used in reporting pupils' progress. Trends of these newer reporting systems reveal a definite move away from a mere statement in percentage grades, letters, and other arbitrary marks of evaluation. Such reports of pupil progress are stated as *outstanding, satisfactory, below average,* and other similar terms. Social values to be reported are stated in such terms as *responsibility, interest, appreciation of workmanship, consideration of others,* and *co-operation,* in contrast with older methods of deportment, 90, and similar inclusive and arbitrary values.

Trends such as the above represent definite experiments in trying to determine whether values stated as goals of education are being realized and in recording the progress of the individual toward these goals.

Techniques and instruments of appraisal must vary as the aims of education vary in different educational systems, for the product of one system cannot be evaluated in terms of another system. The fact that existing techniques for appraising certain of the outcomes are inadequate is evidenced by the constant search for more effective methods. However, the lack of perfected techniques does not free educators of their responsibility for trying to improve existing methods of appraisal or for experimenting to devise new and more effective means.

Lack of appropriate scientific methods of appraisal calls forth a special challenge to workers in more recently established phases of school work. For example, science in the elementary grades is particularly affected by the lack of appropriate methods of appraisal because of its recent entry into the public school as an organized field.

Science in the elementary school organized around larger principles and generalizations is of recent origin. Therefore, time enough for making attempts at appraising

* Excerpt of doctoral dissertation, Contributions to Education, No. 728. Bureau of Publications, Teachers College, Columbia University. Presented before the N.A.R.S.T., Atlantic City, N. J. Spring Meeting, 1938.

certain individual and social outcomes has not elapsed. Also, an evolving philosophy is causing changes within this field. Since these conditions prevail, it is necessary that attempts at appraisals be made.

This study attempts (1) to investigate briefly methods of appraisal which have been used in elementary school work; (2) to select from these the method most appropriate for appraising observable behavior in science in the elementary school; (3) to study teaching practices in certain available school situations; (4) to adapt the selected technique to these schools; (5) to secure data through the use of such an instrument of research; and (6) to state the implications of the results of such a study.

THE CONTROLLED OBSERVATION TECHNIQUE

Experimentation in education is a means of furthering progress. It is a method of finding the worth of that which already exists, of identifying educational values, and of indicating new developments which are worthy of inclusion in educative process.

Before an attempt was made to select the kind of technique best suited to this study, elementary school classes were visited and notes were taken concerning the kind of teaching, the size of the different available classes, and the conditions in general. Next, investigations were made of kinds of techniques which were available for the purposes of this study. The advantages and disadvantages of case histories, personal interviews, rating scales, questionnaires, and pencil-and-paper tests were considered. Then a study of the technique of observation was made. The observation technique was selected because it gave promise of securing a more adequate picture of the natural modes of expression of children without disturbing normal classroom activities.

Briefly stated, the controlled observation technique consists of a number of consecutive daily observations of a group for limited periods of time. For this reason, studies of this kind are known as time sampling studies.

Observations are made in terms of defined units of behavior of individuals or groups. Each unit of behavior is selected and defined so that in its repeated occurrence during observation periods it may be easily recognized and recorded. Units of behavior are assigned code numbers for convenience in recording, and each time such behavior occurs during an observation period it is entered in code on a daily record sheet.

The total number of code listings of a specific kind of behavior which appears during the series of observations represents the group score for that kind of behavior. The total number of all kinds of listings which appear for a given individual is regarded as his score. An individual's behavior in regard to a particular item of behavior is his number of listings for that item.

Goodenough [1] and others have found that only positive behavior should be treated as an individual's score.

The present investigator also found this to be the best procedure because some of the types of behavior listed in the codes did not admit of negative responses. Being able to record negative responses for some kinds of behavior and not being able to distinguish and record them for other kinds, would have given an inaccurate picture of individual and group performance.

Overt manifestations of behavior are so bound up with a number of factors that a complete record of such manifestations is impossible. In the light of these facts, the most practical way of approaching the problem is by securing records of individual and group reactions in terms of comparatively simple units which allow a record to be made of each item as it is repeated.

[1] Goodenough, Florence L., "Measuring Behavior Traits by Means of Repeated Short Samples," *Journal of Educational Research*, Vol. 12, p. 230. 1928.

Since reaction to a situation is to be analyzed in terms of definite, simple codes, several factors which enter into controlled observation must be considered. The method is a subjective procedure which tends to take on an objective character as evidence indicates that other persons acting as checkers are obtaining results comparable to those of the investigator in trial situations. Thus investigators must exercise precaution in providing checks both upon themselves and upon the codes they are using to insure accuracy in selecting the code items under which reactions are to be classified, to insure accuracy of recording, and to establish the reliability of codes. Reliability of codes may be established by having observers work in pairs, the amount of agreement between them being indicative of the reliability of the codes. Code revisions and subsequent paired observations may be necessary in securing the desired reliability.

To insure accuracy of observations, an observer must possess efficient sense organs; he must train himself to focus his attention upon his subjects amid distracting conditions; he must have the ability to make accurate discriminations between code listings as checked by other observers in the description above. An investigator must understand the situation in which he is to work, and he must approach his observations with an open mind. However, it is not necessary that the investigator hold the same educational views as those held by persons in charge of the situation in which he is to work, though he should be familiar with these views and other implications in order to secure unbiased results. In the case of this study it would be only fair to state that the educational viewpoint of the investigator, in several instances, was not that of persons in charge of the situations.

Another factor which must be considered is that since observations are to be made in terms of defined codes during discrete periods of time, the number and length of observation periods must be the same for all individuals or groups that are to be compared. This allows for a direct comparison of frequencies or scores of individuals in making analyses of results. Also, all individuals must be observed under similar conditions during the performance of similar activities or when the individual himself brings about a variation in the type of activity by his own choice.

Still another factor to be considered in recording observations of behavior according to specific codes is that extraneous material which has no relation to the code items must be disregarded. Only such behavior as has direct relation to the kinds of items considered is to be recorded.

In describing a technique which has not been fully developed but which seems to have certain possibilities that make it valuable, it is necessary to point out its advantages and its limitations. The controlled observation technique is a direct method of securing individual and group data in terms of repeated samples of everyday behavior such as is manifested under ordinary conditions. Since this procedure does not disturb normal activity, it makes for more reliable results than are possible when data are taken under such artificial conditions as interviews, pencil-and-paper tests, or other performances where the attention of the individual is consciously drawn away from his normal activity to the process in which he is asked to engage. A classroom of children may continue ordinary work with the observer sitting in an inconspicuous corner, or children may engage in their normal play activities uninterrupted by a casual observer.

The data obtained by the controlled observation technique lend themselves to various kinds of statistical treatment. It is a quantitative method in which the results may be expressed in simple numerical terms that have been treated statistically in order to establish reliability and validity.

Controlled observation may be adapted to the study of different forms of behavior.

It has been used in measuring both group and individual responses in a variety of situations, some of which are: playground behavior of children in reacting to both persons and materials, behavior of children in response to the classroom situation, and appraising teacher conduct of class situations.

Behavior samples taken for short intervals of time upon successive days tend to cancel out the influence of disturbing elements which often arise, thus giving a more accurate picture of the situation as a whole. Hence the distribution of observation time into intervals, rather than taking it as a whole, becomes one of the chief advantages of the technique.

Practically any method of research has certain inherent disadvantages which prove a limiting factor in its application. This technique, like any other, has disadvantages which limit its usefulness. Norms or standards derived from the specific behavior of individual groups should not be compared with those of other groups, unless terms of the definite units of behavior are the same for these groups. In this study no attempts at comparisons of the different schools are made because behavior was coded in terms of the different objectives defined for each particular school.

A disadvantage which has yet to be overcome is that securing enough observations takes a good deal of time. Obviously this limits the use of the technique. However, in the case of extended studies such as the one under consideration, the controlled observation technique seems to be no more time-consuming than other less direct methods of research.

Selection of Schools for Study

In the preliminary survey of the vicinity for appropriate schools in which to make the study, several were found available. It was thought that the results of the study would be more reliable if the controlled observation technique were used under as widely varying conditions as possible. Consequently, two schools, widely divergent as to their objectives and methods, were chosen. Hereafter these schools will be designated as School A* and School B. It should be stressed here that the study is in no way comparative. It makes no attempt to compare the objectives, methods, or results being achieved in these two schools. It attempts to appraise certain observable behavior which appears in the science programs for the elementary grades of these schools in terms of their own objectives. This appraisal necessitated the developing of separate codes of behavior items for each school.

Development of Codes for School A

The criteria for selecting objectives of science in the elementary school were carefully analyzed as to their implications concerning behavior responses of children. Analyses of content outline sheets and mimeographed proposals for a science program in School A were made. From these analyses a skeleton code outline was developed with the criteria for this particular program as a check.

The preliminary development of codes for School A was checked with the originator of the science program for this school, with the classroom teachers, and with the science consultants. Additions and eliminations of code-item categories (critical-mindedness, open-mindedness, etc.) were made in the light of suggestions from these persons.

Code-item categories were arranged in two groups because they seemed to fit naturally into the classification—*dynamic* and *performance* factors. Dynamic factors include desires, attitudes, motives, opinions, and other similar features, while performance factors include participation in class work, responsibility of the individual for doing his share of the class work, and other

* Because of limited space, only the results of Grade 5 in School A will be discussed. For a more complete discussion, the original study should be consulted.

similar types of behavior. Convenience of reference in recording responses was another reason for separating code-item categories into two groups.

Each item of these codes was illustrated by means of examples. These were secured by visiting the classes selected for observation and taking notes of children's reactions to the teaching.

These examples were not intended to be inclusive of all the kinds of behavior which might be exhibited by children during the periods of observation. They were designed to clarify in the mind of the observer the types of responses which would naturally fall under the different items. After revision had been made the completed codes appeared as follows (item 2j was added later as the need for it arose);

CODE 1—SCHOOL A

Directions for use: This code is to be used when the class is planning, reporting, discussing, demonstrating, experimenting, explaining, or constructing in connection with problems or activities which enter into their ordinary working program in science. Observe the group for the entire period, making accurate records according to the code numbers below for each individual. Enter the following codes upon the Tabulation Sheets.

Inquiry . . . . Ia

Enter the code number Ia against the name of each pupil for evidence of any kind of overt behavior which indicates that the pupil is using inquiry as a means of gaining information or ideas pertinent to science work, including sensitive curiosity. Examples are: Pupil asking *what* is the cause of a certain happening; *why* certain procedures were undertaken; *why* an experiment did not work; *how* to read a barometer; pupils asking questions which show thoughtful attitude as opposed to questions which show little or no thinking.

Critical-mindedness . . . . Ib

Enter the code number Ib against the name of each pupil for evidences of critical-mindedness toward the class situation as shown by weighing evidence with respect to its pertinence, soundness, and adequacy. Examples are: Pupil asking for statement of source of information before accepting it; pupil verifying statements read or heard; pupil questioning authority constructively; pupil questioning truth of a statement before he is willing to accept it as final.

Open-mindedness* Ic

CODE 2—SCHOOL A

Pupil responses which show preformance factors in elementary school science.

Directions for use: This code is to be used during the normal work of the class for recording such behavior as reveals pupil performance. Observe the group for the entire period, making accurate records for each individual according to the code numbers listed below.

Enter the code numbers upon the Tabulation Sheets according to directions.

Responsibility 2a

Voluntary activity 2b

Initiative† 2c

The next step to be undertaken was the development of appropriate sheets upon which to record the data. The completed codes and tabulation sheets were tried out in classroom situations to test their suitability. These trials resulted in a few minor changes in code wording for the sake of clarity, and the addition of an item, "Miscellaneous," was found to be necessary to take care of the miscellaneous types of responses which did not apply to other code items. In several cases responses were made which did not fall definitely within other categories but which showed clearly that the individual was reacting to the classroom situation in a positive manner.

ANALYSES OF THE RESULTS OF OBSERVATIONS OF GRADE 5, SCHOOL A

With the point of view in mind—that observation is an instrument of value in appraising certain activities of the educative process—continued observation of science classes in Grade 5, School A, were begun. Records of observations of twenty-five successive classes, or a total of 750 minutes of classwork, were obtained, the

* Other examples of code-item categories are omitted in both codes due to lack of space. See Table I for full list of categories.

† See footnote above.

investigator doing all the observing and recording.

The results of these observations were analyzed and arranged to show both individual and group responses, according to the different code-item categories. Table I provides a complete picture of these results.

A specimen analysis of an individual response will serve to show applications of the results of the observation technique.

Pupil G. Results of observations of Pupil G show 30 responses or 3.30 per cent, in comparison with a median of 23.5. The responses of this pupil were well distributed over the eighteen code-item categories, showing a good balance as to kinds of responses. It should be noted here that it is not expected that each pupil will respond to every item of the two codes, and an examination of Table I will reveal that only one pupil, B-I, responded to all the items. However, a well-distributed set of individual responses indicates a wide range of participation, and thereby an enrichment of experience.

Other examples which illustrate the distribution of responses are Pupils I, N, B-I, and D-I. From the results shown in Table I and from the responses recorded stenographically, Pupil I tended to show more critical-mindedness rather than a balance of responses. Evidences of critical-mindedness appeared 14 times in contrast with the use of cause and effect relationships, which appeared only 8 times. Recognition of achievements of thinking, assuming responsibility for contributing his part to the class, use of skills, and evidence of special abilities were not shown at all.

In comparison with Pupil I, Pupil N showed evidence of critical-mindedness 10 times, but other important items balancing this rather large number of responses appeared as follows: generalizing, 6; scientific problem attack, 7; and cause and effect relationships, 15. Only one item, special abilities, was not evidenced.

Another example of a large number of responses to items of one type is Pupil D-I, with 12 cases of the use of cause and effect relationships. This pupil gave no evidence of the use of scientific problem attack, and gave evidence of generalizing only 5 times. In addition there were no responses to six of the items. This record is rather unusual, considering the unusually high mental age of the pupil, which is 16 years 6 months. This would indicate that the pupil was not being stimulated sufficiently according to her mental capacity.

After considering the above examples, which indicate a balance of the kinds of responses or a lack of it, a further analysis of Pupil G's record, with an average set of responses, will yield more information.

Examples of the kinds of responses given by this pupil are:

Inquiry: I'd like to know what a thermostat is.

Critical-mindedness: T— said smoke couldn't get up through the chimney (of the convection apparatus) if the candle was here (pointing to the chimney of the apparatus). It could too.

Open-mindedness: I never saw a 29.1 (reading) on the barometer, but I suppose there might be one.

Generalizing: When the barometer (reading) is high, it is usually clear; and when the barometer is low, it usually rains.

Scientific problem attack: Highs and lows (pressure areas) work like this: In a high the air is heavier and doesn't have as much moisture. It (the air) comes down and makes the mercury (in the barometer) rise. In a low, the air is lighter and holds more moisture. This (the air being lighter) makes it go up (mercury in the barometer). It (the moisture laden air) goes up until it gets cold. Then the water (moisture) condenses and it rains. We can tell by a barometer (checking results and comparing kinds of weather and barometer readings).

Recognition of interpretations of natural phenomena: Fog is just clouds that are near the ground.

Cause and effect relationships: Smoke goes down here (in convection apparatus) because cold air is heavy. It comes up here because warm air is light.

Voluntary activity: I could bring it to school (reference to weather instrument) and we could use it.

Application of experiences: I have a litle instrument that does that (reference to changing direction of light rays with a toy periscope).

Self-appraisal: I am sure mine is correct, but it is marked wrong.

Resourcefulness: We could trace the highs and lows (movement of high and low pressure

TABLE

RESULTS OF OBSERVATIONS

Pupil	Rank	Mental age	Days absent	Responses to Code 1							
				Inquiry	Critical-mindedness	Open-mindedness	Generalizing	Scientific problem attack	Recognition of achievements of thinking	Recognition of inter-pretations of natural phenomena	Cause and effect relationships
N	1	.....*	2	4	10	3	6	7	1	6	15
B–1	2	10–3	0	15	10	7	7	2	1	4	11
I	3	11–10	2	6	14	7	4	4	0	4	8
D–1	4	16–6	0	6	5	2	5	0	1	1	12
A	5	11–6	0	0	2	1	4	4	0	4	5
Q	6	12–6	0	6	5	0	2	1	0	2	4
O	7	12–8	2	2	3	1	4	1	0	0	4
H	8.5	12–9	0	1	5	0	3	1	0	2	10
J	8.5	11–1	1	4	3	0	1	2	0	3	1
G	10	11–3	2	2	5	2	1	2	0	1	3
V	11	10–0	0	7	3	4	0	0	0	1	2
S	12.5	13–2	2	1	2	1	1	1	0	0	3
C–1	12.5	14–9	0	2	3	0	1	1	0	1	2
D	14.5	10–9	0	10	2	1	0	0	0	0	4
L	14.5	11–11	0	0	5	0	0	1	0	0	2
B	16	11–7	0	1	8	0	0	2	0	1	3
E	18	11–7	0	2	2	0	2	0	0	0	4
P	18	11–10	0	2	5	0	1	0	0	1	2
X	18	12–0	0	4	2	0	1	1	0	0	3
T	20.5	12–5	5	0	2	1	1	1	0	2	2
U	20.5	13–5	1	2	1	1	0	0	1	1	0
K	22.5	13–11	0	0	5	0	0	0	0	2	0
Z	22.5	11–8	4	0	2	0	0	1	0	1	1
M	24.5	12–3	0	2	1	0	0	0	0	1	2
W	24.5	12–1	3	5	1	0	0	0	0	0	1
F	28	11–2	0	3	2	0	1	0	0	0	0
R	28	.....*	16**	0	3	1	0	0	0	1	1
Y	28	11–3	3	1	1	0	0	0	0	0	1
E–1	28	13–5	18**	0	2	0	0	0	0	0	0
F–1	28	11–6	0	0	1	0	0	0	0	0	1
A–1	31	11–5	2	1	2	0	0	0	0	0	0
C	32	13–5	5	0	1	0	0	0	0	0	0
		Totals..........		90	118	32	45	33	4	41	108

* Record not available
** Withdrew after first few days of observations

areas on successive weather maps) to show that air (masses) moves.

Miscellaneous: Pupil G pulled down wall map for another pupil to locate the place under discussion.

The types of responses not indicated by Pupil G's behavior are recognition of achievements of thinking, responsibility, initiative, skills, and special abilities. The lack of response to these items does not necessarily mean that the pupil was deficient in these respects. It indicates that he should be encouraged to assume more of the responsibility for his work, be given more opportunities for proceeding *on his own,* and be placed in situations where more skills would need to be employed and where special abilities could be discovered.

In restating, briefly, the points of the

I

of Grade 5, School A

Responses to Code 2										Totals	Per cent of total number of responses
Responsibility	Voluntary activities	Initiative	Application of experiences	Self appraisal	Resourcefulness	Skills	Special abilities	Work habits	Miscellaneous		
1	13	8	5	2	4	5	0	4	1	95	10.44
1	12	4	3	2	4	1	3	2	2	92	10.12
0	4	3	3	2	4	0	0	5	3	77	8.47
0	3	1	0	0	1	0	0	2	8	47	5.17
0	7	2	1	2	2	0	1	4	0	39	4.28
0	4	3	2	2	3	0	0	1	0	35	3.84
0	8	2	0	1	3	1	0	1	3	34	3.73
0	4	1	4	0	0	0	0	1	1	33	3.63
0	3	3	1	1	1	2	0	1	7	33	3.63
0	3	0	2	2	2	0	0	3	2	30	3.30
0	3	2	2	0	0	0	0	3	2	29	3.18
1	4	0	2	0	0	1	0	2	7	27	2.96
1	5	1	1	1	1	2	2	1	2	27	2.96
0	4	0	0	0	1	2	0	2	0	26	2.86
2	3	1	0	1	3	1	1	4	2	26	2.86
0	3	0	1	0	0	0	1	3	1	24	2.63
0	3	1	0	0	0	1	0	3	5	23	2.53
0	4	1	2	0	1	0	0	1	3	23	2.53
0	3	1	2	1	1	0	0	2	2	23	2.53
0	3	1	2	0	1	1	0	2	1	20	2.20
0	4	0	4	0	1	3	0	2	1	20	2.20
0	3	1	1	0	0	0	0	2	5	19	2.08
1	5	2	0	0	2	1	1	1	1	19	2.08
0	3	0	0	0	0	0	0	2	2	13	1.54
0	2	0	0	0	0	1	0	1	1	13	1.54
0	0	0	0	0	0	0	0	1	2	10	1.10
0	0	0	1	0	0	0	0	0	3	10	1.10
0	2	0	0	0	0	0	0	2	3	10	1.10
0	4	0	0	0	0	1	0	2	1	10	1.10
0	4	0	1	0	0	1	0	1	1	10	1.10
0	1	0	0	1	0	0	0	1	1	7	.77
0	0	0	1	0	0	0	0	0	2	4	.44
7	126	38	41	18	36	24	9	63	75	908	100.00

controlled observation technique for making analysis of individual responses to activities in science in the elementary school, the following are significant. The tabulation of results reveals at a glance a picture of the kinds and amount of individual responses. Possible class averages provide a standard of reference for comparison of the responses of the individual with those of the group as a whole. Diagnosis of individual responses reveals individual needs and provides criteria for modifying teaching procedures to meet specific situations. The quality of the reactions can be judged from the records of responses of individuals. For these reasons the technique is of direct value in appraising children's reactions to observable activities in science, and of indirect value in appraising the appropriateness of activities.

THE USE OF PROJECTS IN THE NINTH GRADE AS A TEACHING PROCESS IN AN INTEGRATED PROGRAM

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The project, as a teaching process, has been made use of with success in nearly all subjects taught in public schools. In a system where projects have been used with better than average success, and where a program of integration of subjects has been in the process of adoption, it was decided that the use of the project could serve an important function of unification in carrying through this program. This idea had an immediate appeal to the pupils in that it meant preparation of one project, so worked out as to fulfill the requirements of all of his courses; whereas, the pupil in previous years had been obliged to prepare a separate project for each subject taken.

One of the first steps in carrying out such a program was the calling together of those teachers who were to take an active part in this experiment. The purpose of the committee meeting was to work out a set of functions which the project should and could serve in this program. These were arranged under three separate headings: (1) the functions of the project itself, (2) the functions of the project in an integrated curriculum, and (3) the major functions of the use of guidance in organizing the project. At this meeting we also worked out a temporary conference schedule.

The conference periods required a great amount of time in terms of total time given to each pupil by all of his teachers. The greatest demands were made upon the librarian. Teachers conferred with pupils individually or collectively, or both. The conference period, in which the pupil met with two or three or even four teachers, has proven most worthwhile. These conferences, in many cases, proved of great value in that pupils and teachers were brought closer together and greater individual assistance could be given.

The organization of the project, after selection had been made, proved, from the standpoint of the teacher, to be a tremendous task. The curriculum offers the following major subjects: English, social studies, mathematics, languages, general science, biology, and typewriting. The minor subjects are wood and metal shop, printing, mechanical drawing, general science, typing, cooking, sewing, and art. From the subjects listed the pupil selects four major subjects and two minor subjects. These, with the special activity periods, make up his schedule. The procedure had previously been for the pupil to select some field of interest in each subject carried and, under the guidance of the teacher, prepare a project based on that interest. In applying the use of projects, in the integrated curriculum, the problem was one of guiding the pupil in such a way as to make him aware of the possibilities of relating project interests in one subject with project interests in another. For example, a pupil taking general science may have decided to prepare a project dealing with chemistry. In his social studies, he may have decided to make a study of Germany. This much having been decided upon, a conference of the major subject teachers and the pupil would be arranged. At this conference, the teachers attempted to help the pupil discover the possibility of developing comparisons in the field of chemistry in Germany and in this country; also, of the influence of political, economic and social conditions on the development of chemistry in Germany. The English

teacher helped the pupil to decide upon the style to be used in composing the written part of the project. One pupil, possessing the ability, might imagine himself as a newspaper correspondent and prepare the written part of the project as though writing for a newspaper. Another pupil might imagine himself traveling through a foreign country. He would, then, write a series of letters to friends or relatives in which he discussed the findings made concerning the subject of the project.

Individuals, unable to handle written expression with facility, were guided in so organizing the project as to make greater use of models, collections, graphs, et cetera. In many cases, pupils taking typing could type the written part of the project during the regular class period. Cover designs and illustrations could be worked out in art class. There was the occasional possibility of making an application to a language course, through translations of articles related to the subject matter of the project, where such articles could be found. Models could be made in shop. Of course, full use of such possibilities was not always made, due to the arrangement of the schedules of the pupils and because the whole idea is still in a state of development.

Cases arose which at first seemed difficult to solve. One, in particular, was that of a pupil who stubbornly insisted that his only interest was to become a lawyer. It was only after considerable discussion and reasoning that a project idea was finally evolved. The pupil prepared a topic on the training and work of a lawyer and, added to this, a fairly successful working model of a lie detector.

The examples of projects set forth above help to point out the various ways projects were used in the program of integration. Of course, as in any other situation where references are used, the written work can degenerate into topics given verbatim with little sense of understanding on the part of the person explaining the project. In such cases the results are dull and uninteresting to the rest of the class. However, through attempting to have the pupil follow some original style of writing, such a practice had small chance of being followed.

The use of projects as a teaching process, in putting into operation this integrated program, is in a state of experimentation and development. As the program is expanded to include more of the subjects taught, further project uses and applications will be found. The project, while not the only factor involved in putting into operation the integrated program, is proving one of the most useful aids in this task. Its use is successfully breaking down undesirable department barriers and showing the interdependence of one department with another. Secondly, its use is not only serving to develop a realization of possible relatedness of facts, happenings and events, but to make applications as well.

SOME MISCONCEPTIONS IN SCIENCE HELD BY PROSPECTIVE ELEMENTARY TEACHERS

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The Problem

Analysis of state courses of study in elementary science reveals that the subject matter suggested ranges over many fields of science. An attempt at an adequate classification of topics involves the use of at least the following headings: agriculture, botany, zoology, forestry, chemistry, physics, astronomy, geology, geography, meteorology, physiology, and hygiene. It is of course true that only the very simplest facts and concepts of these diversified fields are utilized in elementary science; nevertheless, because the subject draws upon so many fields of science, this question arises: are our teachers adequately prepared, under current systems of teacher training, to present this important branch of the elementary curriculum?

The present study attempts to throw some light on the above question by ascertaining the extent to which certain specific misconceptions of scientific facts and principles are entertained by prospective elementary teachers.

Method

From the multifarious facts and concepts suggested in various courses of study in elementary science, a number were selected as most basic and fundamental, and with these as a basis, a group of true-false items was devised. Since the prevention and elimination of superstitious misconceptions are important aims of elementary science, a number of items concerned with common superstitions were added. The resulting test consisted of 240 items.

It should be emphasized that this test was not a general achievement test. No claim is made for the validity and reliability of the test as a whole. We are concerned here merely with the individual items of the test and with performance on these individual items as indices of the extent to which certain specific misconceptions exist. The fact is, indeed, that the subject matter of elementary science is not stabilized enough for any test to make claim for high validity unless designed specifically for schools following a designated course of study.

The test was given to 130 women college students (at a state institution enrolling over 1700), all of whom were preparing to teach in elementary schools. In all probability, most of these subjects would obtain positions within a state in which elementary science was required by state law. Of the 130, 96 were sophomores (just completing the required two-year normal course), 18 were juniors, and 16 were seniors. Fifty-seven were planning to teach in the lower elementary grades, 43 in the upper elementary grades, while 30 who were planning to complete the four-year course were as yet uncertain as to their specific preparation. The following table presents a

TABLE I

Table Showing Pre-College and College Preparation of Subjects in Science

Pre-College		*College*	
Field	*Per Cent*	*Field*	*Per Cent*
General Science	60	Geography	72
Agriculture	9	Methods in Elementary Science	100
Physiology	38	Hygiene	100
Hygiene	30	Chemistry	13
Chemistry	23	Physics	10
Physics	12	Domestic Science	5
Domestic Science	69	Botany	75
Biology	58	Zoology	74
		Bacteriology	5

summary of the training of the group in pre-college and college science.

The subjects were allowed two hours in which to complete the 240 items on the test. All finished within the time, and there were no complaints as to lack of time for proper consideration of the items.

RESULTS

For each of the items the per cent of error was computed. That these per cents of error can be regarded merely as indices of the extent to which misconceptions exist is evident. Assuming that each item is clear and unambiguous, there still remains the possibility of guessing, which would, of course, tend to lower the per cent of error, since the guesses (representative of lack of conception if not misconception) would tend to be distributed equally among the correct and incorrect, whereas they should all fall in the incorrect. Furthermore, a relatively low percentage of error on an item concerned with a most simple and fundamental concept may be as significant, or even more significant, than a relatively high percentage of error on an item judged by the investigators or by the readers as less fundamental.

Lack of space forbids the reporting of results concerning all of the 240 items. Hence, choice has been made of the items considered most significant. This does not mean that the items on which the largest per cents of error were exhibited were necessarily the ones chosen. Both the items themselves and the per cents of error on them were criteria for their inclusion in this paper. Some items upon which success was high were included because of their bearing on other significant items. The items are listed in Table II, which shows the item as it was stated in the test (it may, of course, be either true or false) and the per cent of error on the item. For the convenience of the reader the items have been grouped into six divisions in accordance with the subject-matter with which they deal: (1) the heavens, (2) earth, atmosphere, weather, and seasons, (3) chemical and physical facts and concepts, (4) biological facts and concepts, (5) foods and health, and (6) superstitions. Within each of these divisions, furthermore, the items have been grouped into smaller units, so that those which are closely related in content should not be widely separated in space.

TABLE II

I. THE HEAVENS

Item Number	*Item*	*Per cent of error*
1.	The earth is a planet	3
2.	The sun is a star	13
3.	The planets should be called stars	26
4	The planets all circle about the same sun	34
5.	The solar system includes only one star	85
6.	The moon circles about the earth in about a month	4
7.	The moon is largely responsible for tides on earth	9
8.	There are several moons which circle about the earth, but only one is visible at a time	15
9.	The moon is always actually of about the same spherical shape	22
10.	On a moonless night clouds lie between the sun and the moon	34
11.	The sun is much bigger than any other body in the heavens	41
12.	The solar system does not occupy a millionth of the space in the universe	42
13.	The earth is located at exactly the center of the universe	10
14.	The earth is larger than any other body which circles about the sun	18
15.	The stars are much closer to each other on the average than the sun is to the earth	32
16.	The moon is closer to the sun than to the earth	26
17.	The stars shine because of the light which they reflect from the sun	48
18.	The stars are not visible to us in the daytime because our side of the earth is turned away from the direction in which they are found	12

Item Number	*Item*	*Per cent of error*
19.	The moon shines because it is hot enough to glow	10
20.	On a very cloudy day no light from the sun reaches the surface of the earth	9
21.	The sun is made of the same chemical elements are are found on earth	44
22.	The stars are made of no chemical elements not found on earth	69
23.	The sun remains fixed in position in space	37
24.	The distant stars are fixed in position in space	21
25.	If a planet were not influenced by other bodies, it would move in a straight line once it was in motion	15
26.	If a planet were not influenced by other bodies, it would continue to move at uniform speed once it was in motion	62
27.	A heavenly body which is in motion has to be acted on continuously by a force, or it would soon cease to move	69
28.	It is more natural for a heavenly body to stop itself when it is in motion than to begin motion of itself when it is at rest	32
29.	Stars fall through the sky rather frequently	20
30.	The shooting stars or falling stars we observe are at least millions of miles from the earth when we first see them	62
31.	The handle portion of the "dipper" points toward the North Star	59

II. Earth, Atmosphere, Weather, and Seasons

Item Number	*Item*	*Per cent of error*
32.	The earth is at least millions of years old	10
33.	The primitive manlike ancestors of man probably appeared on earth over one hundred thousand years ago	29
34.	Since the earth was formed there has been a wearing away of the mountains with no upward movement of the earth's crust which would tend to compensate for this wearing away	28
35.	Coal is produced from plants	26
36.	Air is a definite chemical compound	48
37.	On a day when the relative humidity of the air approaches 100 per cent it contains a larger weight of water vapor than of anything else	75
38.	If a quantity of air is warmed up and no water vapor added to it, the relative humidity of the air is decreased	25
39.	During summer the earth is much closer to the sun than in winter	42
40.	The seasons are the result of the varying distance of the earth from the sun	43

III. Chemical and Physical Facts and Concepts

Item Number	*Item*	*Per cent of error*
41.	Water is an oxide	25
42.	Water is formed when most fuels burn	41
43.	Iron rust is heavier than the iron out of which it is formed	31
44.	An explosion of coal dust is a case of rapid burning	19
45.	The pressure of the air is, on the average, about fifteen pounds per square inch	15
46.	The air above a square inch weighs, on the average, about fifteen pounds	45
47.	If a constant force is the only force acting on a body, it causes the body to move at uniform speed	75
48.	If a constant force is the only force acting on a body, it causes the body to move at constantly increasing speed	77
49.	If it were not for the air all bodies would fall at the same speed	65
50.	The force per unit of matter urging a ten pound body to fall is the same as the force per unit of matter urging a one pound body to fall, if both are dropped from the same position	37
51.	There is more heat in a barrel of warm water than in a cup of boiling water	69
52.	Steam is invisible until it is partly condensed	18
53.	The electricity in a lightning discharge is the same kind as used in electrical appliances	27
54.	All matter contains electricity	28
55.	An electrical generator does not really create electricity	21
56.	The volt represents an amount of electricity	52
57.	Radio waves need air to travel on in going from station to station	62

Item Number	Item	Per cent of error
58.	Radio waves travel at the same speed as sound waves in travelling from station to station	29
59.	Sound will travel through a vacuum	27
60.	Sound travels through air faster than through any other substance	40
61.	The loudness of a sound depends on the area of the vibrating body	47
62.	The loudness of a sound depends on the amplitude of vibration of the vibrating body	29
	IV. Biological Facts and Concepts	
63.	All plants are attached and not free to move about	35
64.	Bacteria are plants	24
65.	Bacteria are one-celled	25
66.	Most bacteria are harmful	31
67.	All molds are harmful	20
68.	The whale is the largest known fish	58
69.	The bat is one of several common night-flying birds	69
70.	No animal changes its environment except by moving	39
71.	The carpet or clothing moth makes holes in carpet or clothing during its flying stage of existence	16
72.	All animals are free to move about, as none of them are attached	46
73.	Yeast cells are sometimes created by the fermentation of sweet substances	58
74.	Insects are sometimes produced by the decay of refuse	18
75.	Horsehairs never develop into snakes	17
76.	Light is not necessary for the sprouting of seeds	55
77.	The bee carries pollen in order to repay the plants for the nectar which they have received	27
78.	Mosquitoes inject malaria and yellow fever germs into people in order to weaken and eliminate their enemies	14
79.	Animals which are born alive do not begin life as fertilized eggs	9
80.	All human beings begin life as fertilized eggs	8
81.	If an animal is trained to do tricks, its young will be born with greater ability to do the tricks	6
82.	Children born in a country have a greater ability to learn the language of that country than the language of any other	37
	V. Food and Health	
83.	The white portion of milk is protein in character	35
84.	The lean portion of meat is protein in character	5
85.	Fish are an especially good food for the brain	28
86.	Ordinary undiluted milk is over 75 per cent water	37
87.	The test to determine whether a mushroom is poisonous or not is the blackening of a silver spoon	28
88.	Bad night air is never the cause of malaria	17
89.	Strong coffee is no cure for malaria	21
90.	Sassafras tea purifies the blood	21
91.	Rattlesnake oil is not a cure for rheumatism	16
92.	Pasteurization of milk does not kill all germs	59
93.	Camphor wards off most diseases	6
	VI. Superstitions	
94.	Potatoes grow best if planted during certain phases of the moon	15
95.	Fish bite best during certain phases of the moon	32
96.	The severity of a coming winter can be predicted in the fall from the thickness of the fur of wild animals	32
97.	The cat sees much better at night than other animals do in the daytime	42
98.	The toad does not produce warts when handled	12
99.	Porcupines protect themselves by throwing their quills at their enemies	59
100.	The goat can digest metal objects	26
101.	The ostrich is able to digest any non-poisonous substance	18
102.	Lightning never strikes twice in the same place	16
103.	One should not touch even a small piece of iron during an electric storm	38

Item Number	Item	Per cent of error
104.	All of a person's hair may turn white a few hours after a very severe fright....	56
105.	The weather always clears up after a rainbow..................................	37
106.	There will be very little rain when the points of the moon turn up................	14
107.	The character of an individual can be told by the lines on the palms of his hands..	5
108.	The lives of the people on earth are much influenced by the movements of the stars.	10
109.	If the head of a snake is cut off the snake does not die until sundown............	6

There is much matter for comment and discussion concerning the responses to the items listed in Table II. No attempt will be made to discuss these results in detail, since the reader has the facts at his disposal in the table itself; however, certain generalizations concerning major misconceptions may be educed from examination of groups of items considered together. The numbers in parentheses in the following refer to the numbers of the items as given at the left of the table.

Almost all of the subjects (97 per cent) know that the earth is a planet (1), and a large per cent (87 per cent) think of the sun as a star (2). However, over one-fourth apparently believe that the planets should be called stars (3),[1] and 34 per cent do not conceive of the planets as all circling about the same sun (4). That the great majority of these subjects have a far from adequate concept of the make-up of the solar system is evidenced by the further fact that 85 per cent of them dissent from the statement, "The solar system includes only one star" (5).

That the moon circles about the earth in about a month (6) and that the moon causes tides (7) are concepts apparently mastered by most of the subjects. It is a bit strange to find, however, that 15 per cent concede the existence of more than one moon circling the earth (8), and that 22 per cent were unwilling to subscribe to the statement, "The moon is always actually of about the same spherical shape" (9).

A group of items concerned with size and spacial relationships of the heavenly bodies yielded significant data. The egocentricity of earth dwellers and solar system inhabitants is revealed by the 41 per cent who think of the sun as the largest body in the heavens (11), and the 42 per cent who think of the solar system as occupying more than a millionth of the universal space (12), and the 10 per cent who, pre-Copernican minded, believe the earth to be located at the exact center of the universe (13).

Questions frequently asked by children are, "Why do the stars shine?", "Where are the stars in the day time?", and "Why does the moon shine?". It is evident from the responses to items 17, 18, and 19 that nearly half the subjects in the group could give no adequate answer to the first question and that at least 10 per cent would convey misinformation in replying to the second and third.

A large per cent of the subjects (44 per cent) conceive, apparently, that the sun contains elements not found on earth (21). A substantial increase in the percentage is seen when the question is applied, not merely to the more familiar sun, but to the stars as a group (22). Apparently 69 per cent are of the opinion that elements unknown to earth enter into the composition of the stars.

Items 23, 24, 25, 26, 27, and 28 are concerned with the motion of the heavenly bodies. The percentage of the subjects believing that the sun remains fixed in space (23) is substantially greater than the percentage believing that the distant stars are without motion (24). That many subjects are ignorant of the fundamental laws of motion or unable to apply them to the movements of the heavenly bodies is evident from the responses to items 25, 26, 27, and 28.

[1] Popular books and articles too frequently contribute to this confusion of concept or, possibly, terminology.

The belief of 32 per cent that it is "more natural" for a heavenly body to stop itself when it is in motion than to begin motion of itself when it is at rest shows a decided lack of fundamental understanding that borders upon superstition.

If we may judge from the responses to item 31, 59 per cent of the subjects would be unable to locate the North Star in the heavens, and yet courses of study in elementary science may take it for granted that the teacher is familiar with and able to help the child to locate the major planets, stars, and constellations.

When we come to the group of items dealing with the earth, atmosphere, weather, and seasons, we find that to 10 per cent of the subjects, the phrase "millions of years old" evidently has an exaggerated ring when applied to the age of the earth (32). Two fundamental geological processes, the upward movement of the earth's crust (34) and the formation of coal from plants (35) are among the concepts unmastered by a significant number of the subjects.

Only a few more than half the subjects know that air is not a definite chemical compound (36). The principle involved in the concept "relative humidity" is apparently not understood by at least 25 per cent of the subjects (38), while 75 per cent show a misconception with regard to the proportionate weight of water vapor in the air (37).

That over 40 per cent of the subjects have misconceptions regarding the causes of the seasons is shown by the per cents of error on items 39 and 40, which reveal subscription to the common fallacy that the warmth of summer is due to the greater proximity of the earth to the sun.

Very few chemical facts are emphasized by state courses of study in elementary science. However, combustion is a topic apparently deemed simple enough for inclusion at the elementary level. Items 41, 42, 43, and 44 are concerned with this topic, and the per cents of error range from 19 to 41 per cent.

The per cents of error on items 45 and 46 illustrate how a discrete fact may be mastered without any fundamental grasp of the principle involved. While only 15 per cent of these subjects were unwilling to subscribe to the statement that the pressure of the air is, on the average, about 15 pounds per square inch (45), 45 per cent do not believe that the air above a square inch weighs, on the average, about 15 pounds (46).

Probably one of the most glaring misconceptions evidenced concerned uniform and accelerated motion for 75 per cent of the subjects subscribed to the statement that a constant force acting on a body causes it to move at uniform speed (47). The high reliability of this percentage is indicated by the fact that 77 per cent of the subjects responded negatively to the item, "If a constant force is the only force acting on a body, it causes the body to move at constantly increasing speed" (48). Examination of the data shows that 74 per cent of the responses were consistently incorrect on the two items.

Galileo's startling demonstration from the Tower of Pisa has apparently not effected the thinking of the 65 per cent of the subjects who do not believe that if it were not for the air all bodies would fall at the same speed (49). However, all except 37 per cent are willing to endorse item 50, the formal statement of the underlying principle, probably because it sounded exact, technical, and "scientific".

That a substantial per cent of the subjects do not understand the distinction between heat and temperature (51), several simple facts concerning electricity (53, 54, 55, 56), the nature of radio waves (57, 58), and the nature of sound (59, 60, 61, 62) is indicative of their lack of grasp of very simple and basic facts and concepts concerning physical phenomena.

The items in Table II concerned with biological facts and concepts are divided into three groups, those concerning plants, those

concerning animals, and those dealing with more general biological principles.

As might have been predicted from Table 1, comparatively few gross misconceptions are exhibited with regard to the biological facts and processes included in the test. However, 24 per cent respond negatively to the statement, "Bacteria are plants" (64) and 25 per cent respond negatively to the statement, "Bacteria are one-celled" (65). Moreover, 31 per cent indicate their belief that most bacteria are harmful (66). The whale is a fish to 58 per cent of the subjects (68), while to 69 per cent the bat is a bird (69).

The fact that 58 per cent of the subjects respond positively to the statement, "Yeast cells are sometimes created by the fermentation of sweet substances" (73), may or may not be indicative of a belief in spontaneous generation. However, the percentage is an indication of the ease with which grossly unscientific statements find acceptance; and it is a further fact that 18 per cent of these subjects indicated their belief that insects are produced by the decay of refuse (74) and that 17 per cent indicate a belief in the old superstition that horsehairs may possibly develop into snakes (75).

A curious failure to detect a fallacy was exhibited by 27 per cent of the subjects when they subscribed to the statement, "The bees carry pollen in order to repay the plants for the nectar which they have received" (77). Further evidence of this type of pathetic fallacy is offered by the 14 per cent of the subjects who respond positively to the statement, "Mosquitoes inject malaria and yellow fever germs into people in order to weaken and eliminate their enemies" (78). The naïveté here shown is reminiscent of much that was taught (and is still being taught) in the name of nature study.

Many of the items classified under "Food and Health" might well have been included among the superstitions. It is of much interest to note that apparently 21 per cent of these prospective teachers would drink strong coffee to cure malaria (89); 21 per cent would drink sassafras tea to purify the blood (90): and 16 per cent would anoint their limbs with rattlesnake oil, could they obtain it, were they afflicted with "rheumatism" (91).

The superstitions need, on the whole, no comment, since the individual items and percentages tell the story of the survival in this group of the "unnatural natural history" of the past. For a substantial number of these subjects, the cat sees much better at night than any animals do in the day time (97), porcupines protect themselves by throwing their quills at their enemies (99), the goat and the ostrich have extraordinary powers of digestion (100, 101), etc. It is interesting to note that only 5 per cent indicate a belief in palmistry, while 10 per cent appear to believe that there may be something to astrology (107, 108).

CONCLUSIONS

1. A significant percentage of these prospective teachers exhibited ignorance or misconception of many simple and basic facts and principles, knowledge and understanding of which would be necessary for any adequate presentation of elementary science in the classroom.

2. A significant percentage of these prospective teachers believed many folk superstitions, some of them harmful in themselves and others harmful in that they stand in the way of thinking and rational action.

RECOMMENDATIONS

The following recommendations for the improvement of the training of prospective elementary science teachers are offered:

1. Elementary teachers should be given a special science course which deals with simple, basic, fundamental scientific facts and principles and which takes no account of the conventional divisions of the sciences into specialized fields.

2. This course should be a laboratory course in which the simplest means of dem-

onstrating fundamental facts and principles should be used, means which may later be utilized in the elementary classroom.

3. The science course should be associated with a methods course in elementary science in which attention is concentrated upon giving prospective teachers an insight into the broader purposes and significance of science in the elementary curriculum and upon the organization of specific, psychologically sound plans for presenting science materials in the elementary classroom.

4. Prospective teachers should be, during both these courses, brought into contact with much unspecialized scientific reading on both the child and the adult level and should be given frequent opportunity to measure their growth in scientific knowledge by specially constructed tests used not merely, if at all, as marking devices.

MAKING HOME-MADE GLASS AND CELLOPHANE SLIDES

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Science teachers have available a great many visual aids to supplement other types of experiences. Demonstrations and laboratory experiments are really visual aids of the most effective sort. As the term suggests, visual aids are not separate techniques sufficient in themselves, but aids to other techniques and activities. One cannot show a motion picture or a group of slides without any other related experiences and expect to have children exhibit marked changes in behavior toward any worthwhile outcomes. We cannot assume that boys and girls become educated automatically simply by looking at pictures, any more than they do by watching demonstrations or reading books apart from other experiences. Appropriate visual aids, however, may effectively supplement and make more meaningful almost any experience. While motion pictures have an important role in the teaching of almost any course, home-made slides are particularly valuable for science teaching. These are so easily prepared from low-cost materials that their use should be widespread.

Home-made Slides. While prepared slides may be purchased or rented from different sources, the home-made slide is usually most effective because of its possibility for adaptation to the needs of a particular teacher or class. The simplest of these are the glass and the cellophane slides, which are easily made from common materials without photographic supplies or any particular skill.

Glass Slides. Plain (non-photographic) lantern slide glass can be obtained already cut to size (3¼" x 4") at a cost of from $1.00 to $3.00 per 100. Firms from which these slides may be purchased are indicated in the list at the end of this article. Such purchased slides are usually more satisfactory than cutting one's own slides from window or other glass. The glass is clearer and thinner than window glass, and the slides are uniform in size. Cutting a large number of glass slides by hand takes some little time, and usually results in some waste unless one has had experience in glass cutting.

Use of Old Photographic Plates. Old photographic plates, of course, make excellent glass for lantern slides. The emulsion can be removed by soaking in hypo (sodium thiosulphate) solution for a while, or if that is not available, hot water will soften the emulsion, which can then be scraped off. If the plates are old photographic lantern slides they are, of course, already the right size. If larger than lan-

tern slides, the glass may be cut to size, as suggested above.

Cleaning Glass Slides. Before the slides are used in any way, either for coating or for writing upon directly with ink, they should be thoroughly cleaned. This may be done in a number of ways. The method by which house windows are cleaned may be utilized—using Bon Ami or some other commercial preparation such as Windex. Dipping the slides in alcohol and wiping with a clean piece of cheese cloth is also a good method. However, the slides must be rubbed, at least slightly, to clean them. They cannot simply be dropped in the alcohol and allowed to drain. They should be dried with a clean piece of cheese cloth.

Perhaps the most satisfactory method of cleaning, however, is to use the solution which the chemist uses for cleaning his test tubes, beakers, and other glassware. This cleaning solution is prepared by adding a handful of potassium chromate crystals (K_2CrO_4) to a liter (approximately a quart) of concentrated sulphuric acid. (CAUTION—do not get acid on hands or clothes.) The glass slides are placed in the jar of cleaning solution for a few minutes, removed with a pair of tongs, forceps, or possibly with rubber gloves, and rinsed in hot running water. If running water is not available, a pan of hot water will serve. The glass plates should be handled only at the edges, then stood on edge on paper towels or newspapers to drain and dry.

Writing on Uncoated Slides. A "china-marking" or ceramic pencil may be used for writing directly upon clean uncoated glass slides. These pencils may be obtained from book stores at a cost of about 15 cents. They make a rather broad, coarse mark and are not suitable for fine-lined diagrams or small lettering.

It is also possible to write directly upon a clean glass slide with India ink or with the "water-proof" type ink. This often is satisfactory for a slide or two, especially if permanence is not an important factor. Usually it is difficult to obtain very consistent and permanent results without coating the slide. Particular care should be taken that one's fingers do not touch the glass where the writing with ink is to be, as the perspiration makes it difficult for the ink to adhere to the glass, and often causes "runs."

It is possible to obtain, or even to make, ink specially prepared for writing on glass slides. It is, however, the opinion of many teachers that this is not very satisfactory. The ink usually is difficult to use as it tends to "gum". It is probably more satisfactory, and less expensive, to coat the slides. Diagramming and writing is much more easily done and the ink stays on longer, if the slide is coated.

Coating Glass Slides. Two very simple and inexpensive methods have been found to be particularly usable for coating slides. These are solutions of gelatine in water, and of clear lacquer in lacquer thinner. An extremely small amount of the solute in the solvent is satisfactory—about 1 part to 50 or even 100 in either case.

For coating with gelatine, obtain a small amount of granulated gelatine. This may, of course, be purchased from a drug store or laboratory supply house. Ordinary clear or plain "dessert" gelatine such as Knox Gelatine may also be used. The latter may be purchased from grocery stores for 20¢ per package—enough to coat thousands of slides. Use about one-fourth teaspoonful of gelatine to a cupful of hot water—or 5 or 10 cc. of gelatine to 500 cc. of hot water. Place the solution in a vessel large enough to easily cover a slide, and simply dip the slide in the solution, holding it by the edges. Stand the slide up on some paper towels, newspaper, or blotting paper, and allow to drain and dry. It will be ready to write on in about five or ten minutes.

For coating with lacquer, use a solution of 1 part clear lacquer to 50 or 100 parts of lacquer thinner. These may be pur-

chased from hardware or paint stores. The lacquer costs about 25¢ for one-half pint, and the thinner, 35¢ for one-half pint. A small amount of solution (10 to 15 cc.) will probably coat all the slides one wants to prepare at a given time. This may be applied to the slide with a small brush. The slides should be placed at a slight angle with the table top, rather than laid flat. This may be done by placing one edge of the glass slide on a meter stick or long flat piece of wood, with the opposite edge resting on the table. Newspapers or other protection should be placed under the slides. A larger amount of lacquer solution may be prepared and the slide dipped into the solution, as in the case of the gelatine coated slide. The lacquer evaporates rapidly and the slide is ready for use almost immediately.

The dipped slides have the advantage that both sides are coated so that either side may be used to write upon. With slides which have been coated on only one side, as those coated with lacquer and a brush, it may be desirable to indicate in some way which is the coated side. This may be done by placing a dot of India ink in the upper right hand corner (or some other corner) of the slide.

Writing on Coated Slides. One can write or draw very easily with India ink upon the coated slides. Care should be taken to keep the lines rather fine; a "crow quill" pen is probably the best type to use. These may be purchased for ten cents from stationery stores.

A good plan is to place the slide over squared or graph paper, so that straight and uniform lines may be kept. A margin of about one-half inch all around should be maintained, else part of the writing or drawing will not show up on the screen.

Ground Glass Slides. Ground glass slides can be written or drawn upon with pencil or India ink. Ordinary ink runs easily, and even with India ink a crow quill pen is desirable when using such slides. Lantern slide ink may be purchased which works quite satisfactorily with ground glass slides.

Abrasives which are suitable and easily obtained for making ground glass slides are fine emery or carborundum powder. Valve grinding compound (for automobile motor valves) may be used if other abrasives are not available. The water-base type is more satisfactory than the oil-base type. "Glassive" is an excellent abrasive for use with glass slides. This can be purchased from Teaching Aids Service, at 50¢ per can. Each can will be enough to make approximately 100 ground glass slides.

In general a small amount of the abrasive should be placed on a smooth piece of iron or on a piece of glass plate somewhat larger than a glass slide. Water is added to moisten the abrasive. The glass slide is placed over this mixture and "ground" with a rotary motion. It should be frequently examined until it is ground over the entire surface. Continued grinding will make the slide less transparent.

Using Ground Glass Slides. The main advantage in using ground glass slides is that they may be written upon with an ordinary pencil, and colored with either special lantern slide crayons or lantern slide inks. The colored inks, of course, make for the most brilliant color. Neither the colored pencils nor the colored inks are satisfactory for writing, printing or outlining, however; they may be useful for masses of color.

The chief disadvantages of the ground glass slide is that it cuts down the illumination by a considerable amount, and that it is relatively expensive either to buy or to make. If made, the time involved may be an important consideration. For use in science classes in the secondary school, their choice, except for special purposes, probably would be second to coated slides. For certain phases of biology, and in the elementary school, etched or ground glass slides might be frequently desirable.

Re-using Glass Slides. Any type of glass slide may be easily treated so as to use over again. Uncoated slides which have been written upon with India ink and ground or etched glass slides which have been drawn upon with crayons may be washed with warm water and soap. A pencil or ink eraser may have to be used on etched glass slides which have been written upon with ordinary lead pencil. This may be followed by the warm water and soap. Etched glass slides which have been written upon with the special lantern slide inks may be cleaned with the special solvent which is furnished with the inks.

Used glass slides coated with gelatine may be cleaned with warm water, while those coated with lacquer should be "uncoated" with the lacquer thinner. The plain glass slides should then be cleaned as suggested in the section on *Cleaning Glass Slides* before they are re-coated or used again.

Protecting Prepared Glass Slides. After the slide has been prepared, usually with India ink, it may be used, as soon as dry, in the projector. Continued use, however, will soon scratch and dull the slide unless it is protected in some way.

The usual and perhaps most effective way of protecting prepared glass slides, has been to place another clean slide cover glass over the prepared slide and bind the two together with slide binding tape. A piece of tape about 15 inches in length is needed. This should be moistened, and laid flat on the desk. The two glass slides should then be brought down near one end of the wet tape, so that the edges are in the middle of the tape. The slides may then be turned along the middle of the tape, which will adhere to the glass edges. The corners of the tape will need to be firmed down. A disadvantage of this method of protection is that it uses two cover glasses for every completed slide. It also takes some little extra time. The material on the slide is thoroughly protected, however.

A satisfactory way to protect glass slides that does not involve the use of another cover glass has been found to be a coating of lacquer directly over the prepared slide. This works particularly well with the uncoated slides or with those coated with the lacquer solution. The lacquer should be somewhat less "dilute" than for the under coating previously used however. A satisfactory proportion has been found to be one part of the clear lacquer to one part of the thinner. Of course the lacquer may be put on "full strength" also. Care needs to be taken in applying the lacquer that it flows onto the slide without having to work the brush back and forth over it—else the ink will run. The ink should be perfectly dry, of course, and there should be a good supply of solution on the brush.

If the slide is somewhat detailed or carefully prepared and hence valuable at least in the amount of time it would take to do it over, probably it would be desirable to use the extra cover glass (which costs only about 1 cent) and bind the two slides in the regular way. Where one is not especially needing permanency, and where the using of extra slide glasses is an item (as when one's supply is low) the lacquer coating is quite satisfactory. It has the further advantage of a less bulky finished slide, which facilitates filing as described below, and makes for only half the weight of the other type of finished slide.

Filing Glass Slides. Boxes having partitions separating glass slides from each other are available, or of course may be constructed. Some types use a sort of corrugated metal on each side of the box, which provides grooves into which slides may be placed so as not to touch other slides. Such boxes are likely to be rather bulky, because of the unused space needed for separating the slides. A practical limitation, however, is that one cannot tell just what each slide is about, without lifting them out. Of course it is possible to number each slide and have a key to these numbers on a piece of paper in the box. This usually does not work out too satisfactorily

in practice, however, as the slides seem to have a propensity for getting into the wrong compartments.

A scheme which has obviated some of these difficulties and proven very satisfactory in other ways has consisted of placing the slides in envelopes and writing on the extreme upper edge of the envelope a notation concerning the nature of the slide. The slides may be placed closely together without danger of scratching, and arranged with guide cards in a regular card filing scheme. The notations at the extreme top of the envelopes stand out definitely when the slide is inside, so that they can be easily read as one " thumbs through " a group of slides. Slides on a unit on Air or Colloids may be placed behind a guide card so labelled, without regard to a number scheme or particular order and easily found when desired.

A very satisfactory envelope for this scheme has been the manila pockets used by librarians for the usual book card. These may be purchased for a few cents per hundred—or possibly you have a good " stand-in " with the librarian and can get the donation of a few. These envelopes have the opening on the narrow end, so that when turned the long way, present a good place for writing the notation. Used in this manner the slides and envelopes will fit into the ordinary 3" x 5" card box or drawer—or a special container may of course be constructed.

Cellophane Slides. For the use of typewritten material the cellophane slide is excellent and is very easily and economically prepared. Cellophane slides, cut to size and inserted between a double carbon paper, may be purchased from various commercial companies at prices ranging from less than a cent to 3 or 4 cents apiece. The amber colored cellophane is considered by some to be best because of the smaller amount of glare. Ordinary wrapping cellophane may be utilized and cut to size (3¼" x 4") with shears. It may be purchased in a variety of colors.

Making Cellophane Slides. For typing the cellophane is placed between the double carbon paper, and the whole inserted in the typewriter. A good grade of carbon paper should be used, if one makes his own, cutting it twice the size of the slide and folding it in the middle. The cellophane is placed inside with both carbon sides against it, so that the typing will occur on both faces of the cellophane. A half-inch margin should be maintained all around the cellophane when typing. The ribbon should be arranged as for cutting stencils, so that the type does not strike through it. It is best to use the carbon paper only once, if good clear impressions on the cellophane are desired.

Cellophane may be used for lettering or drawing with India ink, though considerable care needs to be used as the sheets are very thin and a pen point easily pricks through and a blot occurs. Somewhat heavier cellophane than the wrapping type or that usually furnished for typewritten slides is desirable. A satisfactory, though light weight cellophane cut to slide size is distributed by the Teaching Aids Service under the name " celloslide ". These may be purchased for 25 cents per 100, or $1.00 for 500. India ink may be used directly upon such slides without the use of any sort of coating. Care needs to be exercised in drawing or writing upon cellophane, that the fingers do not come in contact with the cellophane, as the perspiration makes it difficult for the ink to " take hold ". A satisfactory device has been found to be a mat cut out of heavy cardboard or metal with an opening about 2½" x 3". The outside dimensions may be the same as those of a slide. This is placed over the cellophane slide and the writing done through the opening, while the slide is firmly held by pressing on the margins of the mat. This also tends to prevent the curling of the cellophane which occurs when the slide is laid flat.

Projecting Cellophane Slides. When the cellophane slide is completed by typing or

with India ink, it may be placed between two hinged cover glasses for projection. The two cover slides are simply bound together along one edge, usually lengthwise, with slide binding tape. The two glasses may then be opened and closed like the covers of a book, and the prepared cellophane sheet placed between them.

The cellophane slide should not be left in a lantern with a strong light source (400 watt bulb or more) for more than ten or possibly fifteen minutes. After this length of time the cellophane will have a "permanent wave" and the typing ink will begin to "run". Material which needs to be presented for a time longer than this should be prepared on a glass slide—or perhaps better, mimeographed or put on the blackboard.

Of course the cellophane slide may be bound between two cover slides with tape, as previously described for glass slides, if it is desired to preserve it permanently. Usually, however, it will be more satisfactory to remove the cellophane from the hinged glasses and simply file the cellophane, leaving the pair of hinged glasses for use with any number of other cellophane slides. The manila library pockets previously described make excellent filing envelopes for the cellophane slides as well as for the glass slides.

Some Sources for Slide Materials

Keystone View Co., Meadville, Pa.
  Lantern Slide Glass, Etched glass, crayons, ink, cellophane, binding tape.

Teaching Aids Service, Jamaica Plain, Mass.
  "Celloslides" (cellophane cut to slide size, without carbon paper), "glassive".

Central Scientific Co., Chicago, Ill.
  Lantern Slide Glass, Ind. Binding tape, etc.

Radio Mat Slide Co., 131 E. 23rd St., New York City.
  Cellophane slides and carbon paper.

Society for Visual Education, 327 So. LaSalle St., Chicago, Ill.

Classroom Notes

The Pony Type Examination.—It is the purpose of this note to suggest a substitute for the Open-Book type of examination. The writer believes that in science teaching, this substitute has a definite usefulness and perhaps it may be as useful in other fields where that same aim is important.

There are many fads and frills in the testing field as well as in the field of curriculum construction. So many times an idea sounds intriguing and without thinking, many teachers begin using it. Frequently, it is just another "hunch" and one that cannot justify its existence on the basis of its purpose.

It is difficult to tell who first allowed his pupils to use their textbooks in an examination. Likewise, no one knows how popular this technique is and by which teachers it is used. Obviously, there are examinations in certain types of subject matter in which the textbooks could not be used and no doubt there are instructors who feel that such a practice should not and could not be used in their own subject or course.

Most authors of textbooks as well as test builders agree that the pupil should be able to apply what he has learned. Certainly, the teacher of science or mathematics will also agree that the memory skill is less important than that of being able to use the material. Chemists do not sit down and memorize the periodic table that they may be able to work any problem or answer innumerable questions involving any or all of the elements. One may however become familiar with the information about a few of these because of his frequent associations with them in his studies or problems.

It was probably an effort to get away from the common practice of testing the pupils' memory of facts that inspired the use of open texts. Questions then could be used that made it necessary for the pupil to apply his knowledge but he wouldn't have to be a walking encyclopaedia in order to demonstrate his real ability. A parrot can memorize words and repeat them in the order given but that wouldn't be an indication of his ability to reason. You may even find studies that indicate that memory correlates positively with so-called intelligence. That however, would still not justify anyone to rank a pupil's achievement in chemistry by the amount of material he had memorized.

Open-book tests may accomplish something. However, there are certain inherent disadvantages that strongly discredit it. Some teachers may be opposed to cramming before examinations and a few may even be opposed to any study before the test. However, the majority will agree that some study and organization of the material, while not entirely essential, is usually quite desirable for pupils of all abilities. Knowing that they will have access to their books in an examination is usually found to cut down on the amount of study that will be done. Both the good pupil as well as the poorer one will feel that if he finds a difficult question, he will probably be able to locate its answer in the textbook when the time comes. There are a few however who will go through their text, organizing it and becoming better acquainted with it.

The plan used by the writer is rather flexible. It too, has as one of its objectives that of making it unnecessary for pupils to memorize details in order to rank high in achievement examinations. Instead of using textbooks, the pupils prepare a page of notes on $8\frac{1}{2}'' \times 11''$ paper and written on one side only. There are usually very few, if any, restrictions placed upon the notes or the way in which they are written. Naturally enough, it is only right to tell the pupil something about the examination. He should be told something about the type of questions, the type of problems, the work that it will cover, and also what type of information will be furnished by the examination itself. For instance, the teacher may even include such data as atomic weights with the problem needing them and therefore it will not be necessary for the pupil to copy down a whole periodic chart in his notes. The writer makes it a practice of having these notes or "Ponies" handed in with the examination paper with the understanding that they will not be graded and neither will they be used in determining the grade on the test in any way. They are used only when checking certain items that have been missed and then only for purposes of analysis and diagnosis. Insofar as some of these notes represent material that is not included in the text but has been recorded from lecture notes, there are chances for errors in transcription or in understanding. It is important that these errors be corrected.

Some textbooks are so arranged that a portion in the rear of the textbook is set aside for tables, constants, and the like. When this is true, the instructor can often allow the pupil access to this portion of the text and in that way no memorization of tables is necessary. However methods and processes will still have to be recalled and applied correctly.

There are many variations of such a plan, no one of which would be suitable to every

occasion. However the problem of the Pony Type Examination carries with it some interesting possibilities for one to explore.

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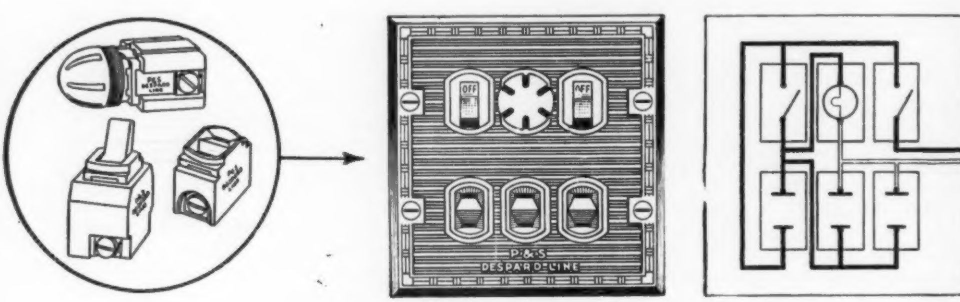
Laboratory Electric Outlet.—In order to have electric current available on laboratory tables it is customary to use ordinary convenience outlets. These have decided limitations for this purpose. An assembly which will prove much better adapted to the experimenter's needs can readily be made up from the small, inexpensive unit devices now on the market. As pictured, the assembly consists of two switches, a pilot light and three outlets grouped to fit a two gang switch box. The right hand or main switch controls all current entering the assembly. The center and right hand, or power, outlets and the pilot light are connected to the line either directly when the left hand or series switch is closed, or through the left hand or series outlet when this switch is open.

The assembly provides (1) two regular outlets controlled by a switch and indicated by a pilot light; (2) an outlet into which resistors such as lamp banks or rheostats may be plugged and connected into the circuit with the flick of a single switch, and (3) a circuit for testing coils and other devices for open or burnt out wires. This latter is accomplished by plugging test prods or the device to be tested into the series outlet and opening the series switch, power outlets not containing any plugs. If the circuit being tested is complete the pilot light will glow.

In order to make the series switch indicate "off" when the assembly is used merely as a power outlet and "on" when the series outlet is connected into the circuit, it is necessary to reverse the action of the switch mechanism. This switch throws the series outlet out of the circuit by shorting the current from the main switch directly to the power plugs. To change the indications of the tumbler handle it is only necessary to remove the back of the switch by prying up the clips which hold the cover, remove the cover and the tumbler mechanism, slip off the bakelite and brass contact blade and replace it in a reversed position so that it makes contact between the stationary contact clips when the handle is in the "off" position. Replace the mechanism and cover and bend the clips back in position.



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Digests of Unpublished Investigations

TRANSFER OF TRAINING IN CHEMISTRY

BY EVELYN L. MUDGE *

UNIT I

PROBLEM.—To determine whether "a year of chemistry in high school produces any gain in (1) knowledge of chemistry, and (2) ability to apply this knowledge to the solution of everyday problems involving chemistry and to the intelligent understanding of popular scientific writing."

METHOD.—An experimental (X-) group composed of 52 pupils of the tenth, eleventh and twelfth grades, and a control (C-) group of 41 pupils of the same grades in one of the large high schools of Washington, D. C., were equated by means and S.D.'s on the basis of mental age, and initial scores on both the Iowa Training Test, Form A, and the investigator's functional test, administered in September, 1932. A comparison of the I.Q.'s and the chronological ages shows the X-group to be somewhat more intelligent (though not to a significant extent) and somewhat younger than the C-group.

The X-group were just beginning work in the regular chemistry course; the C-group took no work in chemistry. In June, 1933, both groups took Form B of the Iowa Training Test and repeated the functional test.

The investigator's functional test consisted of two parts; Part I was composed of "a series of verbal descriptions of situations in which the average person might find himself." It "was drafted from questions prepared in previous years for high school students of chemistry. The majority of the items had been suggested . . . by questions asked by students in the classroom and laboratory." These items were of a modified form of multiple-response test, in which the subject is asked to place in the column marked +, the number of each solution which he considers *effective*, and to place in the column marked —, the number of each phrase which he considers *not effective* or *dangerous*.

Part II, designed to determine the ability of pupils to apply chemical knowledge to the intelligent interpretation of popular scientific literature, was prepared from books selected from a chemistry reading list issued by the American Association for the Advancement of Science. It consisted of both true-false items which the subject was instructed to mark as right or wrong, and items each of which consisted of a series of words accompanied by the direction to draw a line through each one which was not consistent with the idea expressed by the first of the series.

The coefficient of reliability of the test, determined by the Pearson Product-Moment Method from the scores of 98 high-school pupils on the odd and the even numbered items was .81. When corrected by the Spearman-Brown Formula for the reliability of a lengthened test, the coefficient of correlation was found to be .89.

FINDINGS.—1. "Measured in terms of raw scores, the chemistry group gained over twenty times as much as the C-group gained on the training test, and five times as much as the C-group gained on the functional test."

2. "For both groups there is an increase in the mean and the spread of the scores on the training test, but the increase is greater for the group studying chemistry. For the X-group, there is an increase in the mean and spread of scores on the functional test. For the C-group, there is an increase in the mean and a negligible decrease in the spread of scores."

UNIT II

PROBLEM.—To determine the significance of the Findings of Unit I, with respect to "the amount of transfer which occurs from knowledge of chemistry to its application."

METHOD.—The solution of this problem required three sets of computations: (1) correlation coefficients; (2) partial correlations; and (3) standard scores. To secure the first measure, a correlation was made of the gains by the X-group on the functional and training tests. To obtain the second, the partial correlations were taken for the X-group between mental ages and gains on the functional test when gains in training were held constant; and between gains in training and on the functional test when mental ages were held constant. In determining the third, "gains on both tests were reduced to standard scores [mean scores divided by the S.D.'s of the scores] based on the test scores of 80 high-school students who had just completed a course in chemistry."

CONCLUSIONS.—1. "The results indicate that a student who makes a great gain on the

* Unpublished dissertation for the degree of Doctor of Education, Johns Hopkins University, 1935.

training test will probably make a fair gain on the functional test. It does not give any indication of how much of what is learned actually transfers to a practical situation."

2. The coefficient of partial correlation of training and functional gains with mental age held constant, "does not differ greatly from the coefficient of relationship between training and functional gains regardless of mental age. With training gains held constant there appears to be little if any relationship between mental age and functional gain."

3. "In terms of standard scores, 71 per cent is the amount of transfer from knowledge of, to ability to apply, chemistry. This measure is perhaps the most reliable of the three since the gains are in comparable form." "All three measures, however, indicate that there is some transfer."

UNIT III

PROBLEM.—To determine "what residue of factual and functional information persists after an interval of from one to four years since taking chemistry . . ."

METHOD.—Two groups of respectively 29 and 11 Freshmen from Western Maryland College were divided into two comparable groups on the basis of scores on the Thurstone Psychological Examination. The members of the X-group had all had a course in high-school chemistry from one to three years previously; none of the members of the C-group had had such a course. None of the students of either group were enrolled in any college chemistry course.

A year later, these students were tested with Form B of the Iowa Training Test and with the investigator's functional test.

FINDINGS.—"After a period ranging from one to three or four years since taking chemistry, this group, now in college, has a residue on the training test of 3.4 times that of the non-chemistry group now in college."

UNIT IV

PROBLEM.—To determine the "influence of choice of chemistry upon subsequent scores," and "the relation of choice [or avoidance] of chemistry to intelligence . . ."

METHOD.—"Four groups of students from Johns Hopkins University and Western Maryland College were selected on the basis of answers to questionnaires . . . designed to discover which students elected or avoided chemistry and which students had no opportunity to elect it." These groups, designated respectively as the "chemistry-choice group," the "chemistry-no-choice group," the "no-chemistry-choice group," and the "no-chemistry-no-choice group," took the functional test and Form A of the training test. The Thurstone test, together with the functional test and the training test, was also administered to 45 members of the "chemistry-choice group" and to nine members of the "chemistry-no-choice" group.

CONCLUSIONS.—1. ". . . from the . . . data, there seems to be a rather strong indication that students who elect to study chemistry achieve no greater success in chemistry than do those students who take it as a requirement."

2. The data "seem . . . to indicate that there may be some tendency for the less intelligent students not to elect to take chemistry."

UNIT V

PROBLEM.—To determine whether chemical information is retained after the study of chemistry in high school.

METHOD.—The scores made by the high-school X- and C-groups on the Iowa training test and on the functional test were compared with those of both the college X- and C-groups on the same tests.

CONCLUSIONS.—"In so far as the high-school and college groups are comparable," the data indicate "that some residue of chemical information remains after the study of chemistry in high school. The gains on the training test appear to be more permanent than the functional gains." "On the functional test, the gains seem less permanent, if indeed they show any permanence at all."

GENERAL CONCLUSIONS.—1. "The study of chemistry for one year in high school yields significant, measurable, and relatively permanent gains in the knowledge of chemistry."

2. "Growth in knowledge of chemistry is accompanied by significant but smaller gains in the ability to apply this knowledge."

3. "Retention of the facts of chemistry is sustained over a longer period than is the ability to apply the facts."

4. "Both the acquisition of knowledge of chemistry and the ability to apply such knowledge are largely the resultants of instruction in chemistry."

Editorials and Educational News

SCIENCE APPRECIATION AND CONSUMER SCIENCE

That modern life is complex, and is constantly growing more so, no one will deny. The chief cause of this trend is the rapid and bewildering development in the application of science to human needs. This development affects our ethical, social and political life profoundly.

If we are to prepare our students for future citizenship, or even for their present lives, we must give them an understanding of the effects of science on modern living. It is not enough to teach them that the telephone uses an electromagnet or that chlorine is used to purify water.

We are not preparing our students to make intelligent adjustments in a world growing more complex each day. The present approach in teaching and course construction seems to have as its premise that all of our students are preparing for scientific callings in life, whereas only a small percentage is doing so. The result is a tremendous waste of time for the others.

Not long ago all high school art pupils were painfully drilled in rules of perspective and drawing. Little was said about where art and life meet. Art educators soon realized the futility of attempting to make producers of art out of everyone in school, regardless of aptitude or desire to produce art. It was realized that it is more important to educate for the appreciation and consumption of art, because that is what most of the students will be doing as adults. Teachers of art, therefore, began to stress the significance of art in the community, such as in public parks and buildings; in the home: furniture, draperies and clothes; in the theater: costumes, settings, and make-up; and in advertising. Sculpture, architecture, the graphic arts, the biography of artists and the development of art were incorporated in courses. Such an approach meets to-day's needs better than merely drawing baskets of fruit and vases.

A close analogy exists in science education. We are attempting to make producers of science out of the students who come to us. Regardless of aptitude, inclination, or need, we put them through the same routine. Studies show that students forget most of the facts they meet in science courses a short time after they have completed the course. In too many cases the motivation is mainly a desire to finish a subject so as not to be annoyed with it any longer.

Yet, there is great need for intelligent appreciation of science and consumer science. Power dams, railroads, steamships, airplanes, mines, mills, food processing, telegraphs, telephones, radios, x-ray, surgery, medicine, dentistry, housing, heating, lighting, refrigeration, air-conditioning, textiles, printing, sky, earth and water will impinge in some way on the present and later life of the pupil.

No one of our great scientists is expected to know all these fields from a producer standpoint, but as future citizens and consumers, our students should and can be taught their significance in modern life.

The rapid changes in materials, devices, and services is leaving the public more in ignorance each day. A calloused populace knows only to push buttons and to expect miracles, yet sensitive curiosity concerning reasons for happenings is one of the important scientific attitudes.

Science stressing informational recall has not prevented a stupendous annual waste in human and wild life, timber and soil. The implications of communication, transportation and power are oblivious to

most science students. Are we training for citizenship?

The problem of finding a job will face almost every one of our pupils a short time after he leaves school, yet what awareness has he of the wide range of producing and consuming activities going on?

Scientific attitude, democratic citizenship, and vocational guidance are highly desirable objectives. If science appreciation and consumer science appear better equipped to achieve them, then the next movements in curriculum revision should be clear.

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Brooklyn, N. Y.

PROCEEDINGS OF DEPARTMENT OF SCIENCE INSTRUCTION

The 1938 Proceedings of the Department of Science Instruction of the National Education Association are available. Problems at all levels of science education are discussed by Pieper, Knox, Shaw, Mann, Clark, Johnson, Meister, Powers, Neuner and many others. Copies may be secured by sending fifty cents to Harold E. Wise, Treasurer, Teachers College 112, University of Nebraska, Lincoln, Nebraska.

NATIONAL BIOLOGY GROUP ORGANIZED

On July 1, 1938, in New York City the organization meeting of The National Association of Biology Teachers was held.

Fifteen delegates representing approximately 1500 pledged members in thirty-five states, adopted a constitution, elected their officers and established their journal which will be known as THE AMERICAN BIOLOGY TEACHER.

The purpose of this assocation, as stated in the constitution, is to organize the biology teachers on a national basis by local units in order to: spread vital and useful biological knowledge to the general public, encourage scientific thinking and the scientific method, and, through their journal, to make available to biology teachers information concerning the selection, organization, and presentation of biological materials.

This new association was sponsored by the committee on biological science teaching of the Union of American Biological Societies. Dr. Oscar Riddle of Cold Spring Harbor, New York, is chairman of the committee and Dr. D. F. Miller of Ohio State University is the committee's field representative.

The officers of the association are as follows:

President—Mr. M. C. Lichtenwalter, Chicago, Ill.

President-elect—Mr. Malcolm D. Campbell, Boston, Mass.

First vice president—Mr. George W. Jeffers, Farmville, Va.

Second vice president—Miss Lucy Orenstein, New York, N. Y.

Secretary-treasurer—Mr. P. K. Houdek, Robinson, Ill.

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NOTICE TO SUBSCRIBERS

Again we invite subscribers to submit to the Editor for publication articles, classroom notes, and items of interest for our Educational News section.

May we request that articles be not over 2500 words in length and that classroom notes do not exceed 600 words in length.

Our readers are particularly interested in investigations in teaching science, in presentations of actual classroom procedures, in course of study innovations, in club activities, in committee activities, in curricular changes, and in the tricks of the trade of the skilled teacher.

Let us hear what you are doing.

Abstracts

SCIENCE IN EDUCATION

Kirkpatrick, Paul. "A Survey of Surveys." *The American Physics Teacher* 6:74–77; April, 1938.

In this article the authors of survey textbooks are somewhat roundly taken to task. A few quotations: "Heil's *The Physical World* . . . devotes over 400 of its 534 pages to physics and only two pages to geology. . . . Those scientists who are genuinely concerned about some of the present trends in science education should find in this book (Jean, Harrah, Herman and Powers) many things to justify their worst fears. Unquestionably this text is defaced by many amazing mis-statements. . . . *College Physical Science* by McCorkle and Lewis marks an achievement in the arts of omission and condensation. . . . Bawden's *Physical Universe* contains altogether too many erroneous statements and careless oversights to be lightly forgiven." The author seems to believe that Richards' *The Universe Surveyed* and Brownell's *Physical Science* the best survey books in physical science yet published. Abstractor's note: It is probably merely an oversight or ignorance of their existence that caused several physical science survey texts to be omitted from the discussion. —C.M.P.

Ambrose, Luther M. "The Training of Teachers of Science in Kentucky." *School Science and Mathematics* 38:126–133; February, 1938.

This article reports an extensive investigation of the conditions existing in 1937 with respect to the teaching of science in 833 high schools of Kentucky. The report presents interesting data of various sorts and ends with a number of recommendations for the improvement of science teaching and of the requirements of science teachers in Kentucky. —F.D.C.

Zechiel, A. N., and McCutchen, S. P. "Reflective Thinking in Social Studies and Science." *Progressive Education* 15:284–290; April, 1938.

The authors of this article are members of the Curriculum Staff of the Commission on the Relation of School and College of the Progressive Education Association. They set forth the task of the secondary school in this way: "The schools must develop students who can think intelligently or scientifically; who are concerned for the welfare of others; who can participate effectively; and who have rich many-sided personalities."

They show the implications of one of these purposes—to help develop students who can think scientifically—in the fields of science and social studies. A simple analysis of the steps involved in scientific thinking is presented. It is pointed out that if the student is to define and describe problems for himself, collect, organize and interpret data, draw conclusions, and act in accordance with his conclusions, he should be given opportunity to gain experience in doing it under the guidance of skilled and efficient instructors. This necessitates using content in which problems will be found that are of importance to pupils and using a method that allows the student to do his own thinking.

A brief summary is given of the way one teacher organized and presented teaching materials in an effort to develop in his pupils the scientific method of work.

This type of teaching calls for wide variety of reference materials of a semi-technical nature that are easily accessible as in a classroom library and also a redistribution of laboratory materials so that classroom and laboratory will be a workroom.

All progressive science teachers will find this an excellent and stimulating article. —F.G.B.

Hendricks, B. Clifford, and Handorf, Benjamin H. "Examination Practice in General College Chemistry." *Journal Chemical Education* 15:176–179; April, 1938.

The authors analyzed about fifty examinations in general college chemistry with a view to determining objectives of the course as indciated by questions asked, subject matter areas covered, and miscellaneous data as to number and form of questions, and so forth. The results show no startling or radical departures from traditional subjective examination techniques. They do reveal that about two-thirds of the instructors submitting the examinations are dissatisfied with them. —V.H.N.

Fernelius, W. Conard, Quill, Lawrence L., and Evans, Wm. Lloyd. "Experiences Teaching Proficiency Students in Chemistry." *Journal Chemical Education* 14:427–433; September, 1937.

The Ohio State University regularly offers two parallel courses in general chemistry, one for freshmen who have not had chemistry in high school, the other for those who have. However, this arrangement has not proved adequate to meet the needs of all students. For four years students showing unusual strength on the basis of a placement examination and a special proficiency examination, consisting of a written exercise and a test of laboratory performance, have been permitted to take a proficiency course in lieu of either of the regular courses. The purposes of this course are to make up whatever deficiencies exist by reason of these students not

having taken the regular courses and to go more deeply into chemistry covered by these courses. The performance of the proficiency students is consistently superior, and they are characterized by unusual interest in chemistry and singularity of purpose. About half of them come from the College of Engineering and more than a third more from the College of Arts and Sciences. Nearly one-half are in chemistry, chemical engineering, and closely allied curricula. The authors feel that the experiment accomplishes certain worthy ends, and is successful enough to be continued. —V.H.N.

OTTO, CARL. "The Correlation of Grades Received by Students in Successive College Chemistry Courses." *Journal Chemical Education* 14: 381–383; August, 1937.

It is shown that a substantial positive correlation exists between marks in successive courses in chemistry in this institution (University of Maine). Marks in early less specialized courses are more valuable for prediction than those obtained in more specialized courses. —V.H.N.

BILLINGER, R. D. "Lecture Demonstration Experiments." *Journal of Chemical Education* 14: 375–377; August, 1937.

The requirements for a successful demonstration are that it should (1) explain a definite principle or process, (2) be brief, (3) not be too complicated, (4) be done with apparatus large enough to be seen easily, (5) be fool-proof as possible. The author goes on to describe three experiments which meet these criteria. They are (1) the contrast process for pulfuric acid, (2) preparation of oxygen from potassium chlorate, (3) demonstration of vapor pressure constant. —V.H.N.

WALLACE, EARL K. "A Survey of Chemistry in Women's Colleges." *Journal Chemical Education* 14: 285–294; June, 1937.

A survey of chemistry in 101 four-year women's colleges in the United States is reported. Common practice is to offer two semesters of general inorganic chemistry, and one semester each of qualitative analysis and quantitative analysis. Others frequently offered are organic, physiological, food, and physical chemistry. Also courses in the teaching of chemistry and the history of chemistry are often given. The most frequently required science subject for a degree is chemistry. It was found that most of the colleges do not offer enough chemistry to permit their graduates to begin graduate work in chemistry without further study. The deficiencies are, however, slight in most instances. These colleges generally do offer enough work to justify a major in chemistry. Less than two per cent of the juniors and seniors major in chemistry. The faculty is well trained, the predominating degree being the Ph.D. Approximately 40% conduct research besides teaching. —V.H.N.

PHELAN, EARL W. "The 1936–1937 College Chemistry Testing Program." *Journal Chemistry Education* 14: 586–590; December, 1937.

The results of the use of the Cooperative Chemistry Test for colleges in 162 colleges are given and analyzed. The number of students tested was 9,504. Comparisons are made by types of colleges, size of class, sex, and a number of other factors. —V.H.N.

GLASOE, P. M. "The Chief Sin in First-Year College Chemistry Teaching." *Journal Chemical Education* 15: 14–16; January, 1938.

It has been shown that when college freshmen are given the same course in general inorganic chemistry regardless of whether or not they had chemistry in high school, the accomplishment of the two types of students as groups is about equal. The author believes that this is an indictment of the methods of giving chemistry in college. Those who have had chemistry in high school should be made to build upon what they have already learned about chemistry. The attitude of the college instructor should be one of encouraging the student to remember and use what he learned, rather than reminding them continually that they really know nothing about chemistry. —V.H.N.

SIMONS, J. H. "Qualifications for Teachers of Chemistry." *Journal Chemical Education* 15: 18–23; January, 1938.

Teachers of high school chemistry should be alert and have well trained minds. They should be carefully selected and given a "rigorous schooling—in a sound curriculum containing an ample amount of chemistry." The requirements in special educational courses should be reduced to a minimum. —V.H.N.

FRUTCHEY, F. P., AND HENDRICKS, B. CLIFFORD. "Constructing and Validating Examinations." *Journal Chemical Education* 15: 40–43; January, 1938.

This report describes the application of two methods of measuring the degree to which various important objectives of instruction in chemistry have been attained. The direct method consists of having students write what they know in their own words. The indirect method consists of a variety of exercises which parallel in each case the direct question on each objective but which require only recognition of right and wrong concepts. In every instance the agreement between the results obtained by the respective methods is high. Since the indirect method requires less time and seems to be equally valid, it is preferable. —V.H.N.

GRADY, ROY I., AND CHITTUM, JOHN W. "The Chemist at Work." *Journal Chemical Education* 15: 167–176; April, 1938.

This is a symposium of persons engaged in different fields of chemistry describing their respective types of work. Types included are plant chemistry, chemistry in insurance, chemistry in

nutrition, chemistry in the lead-silver smelter industry and chemistry in the glass industry.
—V.H.N.

GRADY, ROY I., AND CHITTUM, JOHN W. "The Chemist at Work." *Journal Chemical Education* 15: 222–237; May, 1938.

A continuation of the series begun in the April issue. This includes the medical technologist, the chemist in sugar industries, the chemist in government laboratories, the chemist in the water resources laboratory, the chemist in research and plant control, the chemist in manufacture of electrical appliances, the chemist in invention, and the railway water chemist. —V.H.N.

GRADY, ROY I., AND CHITTUM, JOHN W. "The Chemist at Work." *Journal Chemical Education* 15: 271–285; June, 1938.

This is a continuation of the series of short articles by authorities. This issue includes work with chemical abstracts, with the chemist in the pharmaceutical industry, in the canning industry, in university teaching, in an agricultural experiment station, and in the glass industry.
—V.H.N.

MOULTON, HAROLD G. "Science and Society." *Science* 87: 173–179; February 25, 1938.

This was the introductory lecture to the first of a series of five conferences on "Science and Society" to be held by the American Association for the Advancement of Science. The general theme of this first conference was "Fundamental Resources as Affected by Science." —C.M.P.

RIDDLE, OSCAR. "Progress in Forming a National Association of Biology Teachers." *The Teaching Biologist* 7: 101–103; April, 1938.

This is a progress report of the Committee on the Teaching of Biology of the Union of American Biological Societies. A meeting of delegates has been called for July 1, 1938, to meet in New York City. —C.M.P.

WINOKUR, MORRIS. "Needed Research in Biology Education." *The Teaching Biologist* 7: 113–117; May, 1938.

This is a resumé of the reports of the Research Planning Committee. Four broad areas were considered: (1) determination of content, (2) classroom learning and teaching, (3) evaluation of the learning products, and (4) extra-class activities. Dr. Frederich L. Fitzpatrick presenting the first area pointed out that pupil interests cannot be used as the sole guiding force in the determination of content. A more promising procedure is an amplification of the old "response to objects" methods. Comparative difficulty of topics is a factor to be considered in selecting content. The biology needed for a general education is a survey of the environment. Professor Charles J. Pieper discussed methods of learning and teaching, pointing out the necessity for analyzing the goals of biology instruction. Few problems in the area of methods in biology have been solved, and confirmed. Dr. S. Ralph Powers discussed the evaluation of learning products. One important learning product in need of evaluation is the scientific method. Another important problem is the obtaining of a coherent picture of the world. Dr. Morris Meister discussed extra-class activities. A fundamental problem of biology teaching is to direct extra-class activities more effectively toward the goals of science education. The biology teacher has the tools, the students and biological materials for determining interests, evaluating courses of study, testing the effectiveness of teaching techniques, and judging the outcomes of instruction. Research efforts should be specific and directed. —C.M.P.

NELSON, V. E. "Selling the Chemistry Department to the Public." *The Iowa Science Teacher* 4: 6–12; March, 1938.

Chemistry may be most easily sold to the public through the medium of interesting, capable lecturers, and through exhibits and demonstrations.
—C.M.P.

GAGER, C. STUART. "Pandemic Botany." *Science* 87: 285–292; April 1, 1938.

This is the address of the retiring president of the Botanical Society of America, given at the "Dinner for all Botanists" at Indianapolis, on December 29, 1937. In this engaging article, Dr. Gager states that the responsibilities of scientists are three-fold: to extend knowledge by investigation, to give formal instruction in schools and to enlighten the general public by popularizing. In this latter area, the scientists have fallen down woefully. —C.M.P.

LEVI, HERMAN S. "Ineffective Geography Teaching—Why?" *The Journal of Geography* 37: 185–188; May, 1938.

Based on the results of a survey the author comes to the conclusion that ineffective teaching of geography may be due to inadequate time allotment, insufficient number of specialists trained to teach the subject, the teacher's lack of interest in teaching geography as a separate subject, too great a spread of geography classes among teachers regardless of interests or licenses, lack of utilization of current magazines as teaching aids, and lack of travel and professional training among geography teachers. —C.M.P.

SMITH, ALPHEUS W. "Unfinished Business for Physics Teachers." *The American Physics Teacher* 6: 113–119; June, 1938.

Social and economic changes demand that those engaged in teaching physics clarify their objectives, broaden their interests and intensify their training. Most physics teachers have meager training and, in addition, few physics teachers continue in that capacity only for a short time. There is hope for changing the continuing downward trend of physics enrollment if physics teachers face the problem intelligently.
—C.M.P.

SYMPOSIUM. "Where Are Superior Physics Students Found?" *The American Physics Teacher* 6: 85–98; April, 1938.

This is a preliminary report of the 1936–37 College Physics Testing Program. College introductory physics courses vary considerably from institution to institution. In some cases entire classes fail to reach the national 25 percentile. The same relative positions are maintained by colleges from year to year. Individual students vary widely. The engineering group ranks highest, followed by the teaching group. (This would seem to be strange in view of the recent reported findings of another committee.) In fact, the teaching group excelled all others in two units—sound and modern physics.

—C.M.P.

NORRIS, WILL V. "A Study of Laboratory Manuals." *The American Physics Teacher* 6: 135–138; June, 1938.

This is the resumé of a study of 53 college physics laboratory manuals listing 3,343 experiments. The per cent of experiments listed in six divisions: (1) measurement 4.8 per cent, (2) mechanics 28.3 per cent, (3) heat 13.9 per cent; (4) sound 6.2 per cent, (5) electricity 28.3 per cent, and (6) light 18.5 per cent. —C.M.P.

RIDDLE, OSCAR. "Educational Darkness and Luminous Research." *Science* 87: 375–380; April 29, 1938.

Major theses presented in this article include: (1) present failure of our secondary schools to educate in satisfactory degree is recognized by many of those who are competent to pass judgment, (2) in this country instruction in life science has deteriorated rather than advanced during the past third of a century, (3) there is widespread failure of educators and public school administrators to recognize and to utilize the great intellectual achievements of this scientific age. Many of the values of life-science are pointed out. —C.M.P.

GENERAL EDUCATION

ANONYMOUS. "Relatives Are Helpful." *Science News Letter* 33: 230; April 9, 1938.

Friends and relatives are the most important factor in young people getting jobs. In a selected group, of all those who had ever had a job 70 per cent had learned of their last job through friends or relatives, about 15 per cent through canvassing and only 10 per cent through advertisement and employment agencies. —C.M.P.

ANONYMOUS. "From High School to College." *Research Bulletin of the National Education Association* 16: 63–122; March, 1938.

The major topics discussed in this Bulletin include: (1) the quest for further education, (2) guidance with respect to college entrance, (3) entrance requirements and admission procedures, (4) introducing the student to college life, (5) the freshman curriculum and methods of teaching, (6) the guidance and supervision of college freshmen, (7) use of records in freshman guidance, (8) cooperative attempts to improve articulation between high school and college, (9) summary of current practices affecting college freshmen, and (10 selected references. There are seventeen charts. —C.M.P.

DOUGLASS, HARL R., AND FILK, ANNA V. "Teaching Practices in Junior High School." *Social Education* 2: 330–332; May, 1938.

This is a resumé of an investigation made in social studies, based on replies from sixty-two teachers. The "telling" or lecture method has by no means been abandoned in introducing new material, stimulating interest, and in treating subject matter of considerable difficulty. Most of the teachers make considerable use of collateral reading, although only a small number employ some written check to see that the reading is done. Oral reports are usually given.

A substantial number of teachers report the use of problems, but less than a third regularly use large-unit assignments. The use of projects, as well as the use of the Morrison plan, appears to be limited. About one fourth of the teachers use workbooks and slightly more require daily written work. Socialized recitations are not used as frequently as might be expected. Newer visual aids are little used. Maps, charts, pictures and bulletin boards are used. Few excursions or field trips are taken. Standardized tests are not used regularly. Nearly all teachers provide some training in study habits of pupils. Most teachers do not follow a rigid practice in dividing the class period for supervised study.

—C.M.P.

HARDING, T. SWANN. "The Myth of Excess Productive Capacity." *Social Frontier* 4: 250–253; May, 1938.

The main thesis developed in this paper is that we do not know what we are talking about when we use the terms "excess productive capacity," "wealth" and "plenty." Engineers and economists need to get together to set up authoritative definitions for future use. —C.M.P.

RATH, LOUIS E. "Evaluating the Program of a School" and "Techniques for Test Construction." *Educational Research Bulletin* 17: 57–114; March 16 and April 13, 1938.

The first Bulletin reports on the extensive testing program in one of the thirty schools cooperating in the eight year study of the Progressive Educational Association. This evaluation is developed under the following heads: newer conceptions of evaluation, evaluating the program of the Lakeshore School and interpretations of data.

The second Bulletin describes the techniques for test construction, measuring the ability to apply scientific principles, measuring the interpretation of data, and evaluating some aspects of proof. Much of the material reported relates to science. —C.M.P.

ELEMENTARY SCIENCE

UNDERHILL, O. E. "Physical Science Activities for the Elementary School." *N.C.E.S. News Notes* 4: 216–219; January, 1938.

This article presents discussions and demonstrations on how power is developed from expanding gases. The major concept developed in the unit is: "The greater part of the power which does the work of the world is derived from expanding gases." —C.M.P.

PARKER, BERTHA M. "Five Don'ts for Elementary Science Teachers." *N.C.E.S. News Notes* 4: 230–231; March, 1938.

The five don'ts listed are: (1) Don't urge children to generalize from insufficient data, (2) Don't give the impression that questions of science can be settled by a show of hands, (3) Don't let children perform individually experiments which, if accurate results are to be had, call for a degree of skill in manipulating apparatus above that commonly found among children of the elementary school level, (4) Don't take it for granted that children will fail to observe flaws in technique in the performing of demonstration experiments, and (5) Don't keep living materials in the science room for so long a time before they are to be studied that the children come to regard them as a part of the furniture of the room. —C.M.P.

LUNT, JOSEPH R. "A Demonstration Lesson in Elementary Science." *N.C.E.S. News Notes* 4: 232–234; March, 1938.

This is the resumé of an elementary science demonstration lesson presented at the Philadelphia meeting of the National Council on Elementary Science. The problem of the demonstration was: "How do cold and heat affect things?" —C.M.P.

PHIPPS, DOROTHY. "Science Demonstration Centers as a Method of In-Service Training." *N.C.E.S. News Notes* 4: 209–211; January, 1938.

This article describes the method being used in the Chicago city schools to solve the in-service training problem of elementary teachers as it is related to science teaching. The plan involves the use of a series of science demonstrations at selected school centers. Criteria were set up to serve as guiding principles in deciding upon the nature of the demonstrations used. —C.M.P.

EVANS, GLADYS. "Exploring the Firmament." *Education* 58: 80–84; October, 1937.

The author, a teacher in the Roosevelt School, Long Beach, California, describes the development of an extensive study of the heavens made by a sixth-grade class. She discusses with considerable detail the three major activities of the class which are the following:

Locating in the heavens certain well-known constellations.

Studying about the movements of the earth and the relation of the earth to members of the solar system.

Building a planetarium. —F.G.B.

VINAL, WILLIAM GOULD. "Nature Recreation in New York City." *School Science and Mathematics* 38: 163–185; February, 1938.

This article is a contribution to the long series which the author has published on the nature education available in various cities. It begins with a discussion of historical aspects and follows this with brief discussions of many institutions offering facilities for nature education. —F.D.C.

VINAL, WILLIAM GOULD. "Nature Recreation in Chicago." *School Science and Mathematics* 38: 300–322; March, 1938.

This article, the latest in an extensive series, each discussing nature recreation in one of the great cities, is, like the others, of value to the teacher or pupil who wishes to use the resources of a great city in increasing his knowledge of science. The article begins with a discussion of the historical background of the city; the latter part is devoted to brief discussions of the various agencies and facilities for nature recreation. —F.D.C.

HADSALL, LEO F. "How Animals Protect Themselves." *Science Guide for Elementary Schools* 4: 1–33; November, 1937.

The following topics are discussed: (1) fundamental needs of all living things, (2) the need of protection, (3) protection against unfavorable environments, (4) keen senses as protective aids, (5) protective form, (6) protective colors, (7) freezing, (8) protective coverings, (9) death feigning, (10) shedding structures, (11) intimidation, (12) protection through locomotion, (13) protection through combat, (14) protection through group organization, (15) protection through intelligence, (16) suggestions to teachers, and (17) bibliography. —C.M.P.

MASTEN, JOHN W. "Orchard and Garden Fruit Trees of California." *Science Guide for Elementary Schools* 4: 1–28; December, 1937.

This is an excellent pamphlet of fruits grown in California. Suggestions for study are made for three grade levels. —C.M.P.

DENBIGH, B. R. "Weeds." *Science Guide for Elementary Schools* 4: 1–35; January, 1938.

This is a brief, practical, fairly complete

treatise on weeds. Topics treated: (1) what causes a plant to become a weed, (2) introduction of weeds, (3) weeds in California, (4) disbursement of seeds, (5) poisoning by weeds, (6) cases where weeds are beneficial, (7) cases where weeds are detrimental, (8) control of weeds, (9) suggested activities, (10) weed names, and (11) bibliography. —C.M.P.

BRAUER, OSCAR L., BRUBAKER, LESTER H., DAUGHERTY, LYMAN H., AND HAZELTINE, KARL S. "Products of Wood and Similar Substances." *Science Guide for Elementary Schools* 4: 1–36; February, 1938.

This unit for elementary science teachers discusses the following topics: (1) the lumber industry, (2) lumbering operations, (3) cutting the lumber, (4) grades of lumber, (5) use of lumber, (6) table of uses of woods of common trees, (7) grain in wood, (8) key for identification of a few western economic woods, (9) wood distillation, (10) paper and its uses, (11) cellulose fibers, (12) synthetic cellulose products, (13) coal and coal products, and (14) bibliography.
—C.M.P.

CROUCH, JAMES E. "Winter Birds." *Science Guide for Elementary Schools* 4: 1–36; March, 1938.

While this bulletin on winter birds describes those found in California, much of the information is just as applicable to winter birds found in other states. Topics covered include: (1) foods available, (2) adaptation of winter birds, (3) enemies of winter birds, (4) conservation, (5) description of some common birds, (6) suggestions to teachers, and (7) bibliography. Suggestions to teachers include: (1) field excursions, (2) feeding stations, (3) photography, (4) keeping a bird chart, (5) plotting migration routes, and (6) making casts of footprints. —C.M.P.

PALMER, E. LAURENCE. Electricity and Magnetism." *Cornell Rural School Leaflet* 31–32; March, 1938.

This excellent leaflet discusses the following topics: (1) star study box, (2) an electric burglar alarm, (3) an alarm for moth study, (4) an electric bell, (5) an electrical signalling device, (6) an electric guessing game, (7) to wire a doll house, (8) switches, (9) plugs, (10) fuses, (11) electric heating machines, (12) electric lights, (13) hookups in series and parallels, (14) detecting an electric current, (15) something about insulators and conductors, (16) further experiments with liquids, (17) an electromagnet, (18) a simple telegraph set, (19) a magic toy navy, (20) permanent magnets, (21) magnets in doorbells and telephones, (22) a simple motor, (23) electricity produced by friction, (24) current by chemical action, (25) electricity from storage batteries, (26) induced electrical currents, (27) transformers and induction coils, (28) alternating currents, (29) other rôles played by electricity, and (30) references.
—C.M.P.

LOWRIE, DONALD C. "How Spiders Live Over Winter." *Biology Briefs* 1: 1–2, 5; January, 1938.

The various wintering habits of some fifteen species of spiders are considered. Illustrated.
—C.M.P.

SIGLER, H. "Some Notes on the Carnivorous Plants Found in the United States. The Pitcher Plant." *Biology Briefs* 1: 20–21; March, 1938.

This is the first of a series of articles on carnivorous plants. The Pitcher Plant dates back to Cretaceous times. An excellent description of the pitcher plant is given. —C.M.P.

KITTNER, F. M. "The Banana." *Biology Briefs* 1: 17–19, 23; March, 1938.

This is a brief illustrated article on the life history of the banana. —C.M.P.

MITCHENER, HOPE, AND HARTMANN, VIOLET THOMAS. "A Bird Unit." *The Grade Teacher* 55: 30: 49; April, 1938.

This is an elementary science unit for primary grades. —C.M.P.

SOURWINE, MILDRED. "Sunshine and Rain." *The Grade Teacher* 55: 28, 72–73; April, 1938.

This unit for the primary grades on weather lists aims, outline for study and seat work.
—C.M.P.

BLOUGH, GLENN O., AND BRINK, IDA. "The Study of an Aquarium." *The Grade Teacher* 55: 32–33, 72; April, 1938.

This elementary science unit is intended for primary and intermediate grades. —C.M.P.

WILKS, WILLIAM TAYLOR. "Laboratory Activities for a Unit in Food." *The Grade Teacher* 55: 36; April, 1938.

This is an elementary science unit designed for intermediate and grammar grades. —C.M.P.

BLOUGH, GLENN O., AND BRINK, IDA K. "Fish." *The Grade Teacher* 55: 36–37; May, 1938.

This is an illustrated unit for the grammar grades. Topics considered are: (1) Observation on fishes, (2) How fish breathe, (3) Food of fish, (4) Fish in winter, (5) Things to do, and (6) Bibliography. —C.M.P.

JUNE, MARTIN W. "The June Beetle." *The Grade Teacher* 55: 14, 68–69, 81; June, 1938.

This is a practical elementary science unit that includes description of enemies, methods of control and pupil activities. —C.M.P.

ROKUSEK, ANNE. "How Animals are Protected." *The Instructor* 47: 19, 70–71; April, 1938.

This is an elementary science unit designed "for all grades." Objectives, approach, procedure, activities and culmination are included.
—C.M.P.

JUNIOR HIGH SCHOOL SCIENCE

Zapf, Rosalind M. "Superstitions of Junior High School Pupils. Part II. Effect of Instruction on Superstitious Beliefs." *Journal of Educational Research* 31: 481–496; March, 1938.

The purpose of Part II of this extensive study "was to determine to what degree the superstitious beliefs of junior high school pupils may be reduced by a course in general science which is definitely directed toward the elimination of superstitions."

"The methods of instruction employed were based upon the assumption that a superstitious attitude indicates lack of ability to sense cause and effect relationships and is, therefore, the exact opposite of a scientific attitude. Scientific attitudes necessitate habits of clear thinking, openmindedness, careful observation of data, suspended judgment, criticism, weighing of evidence and a search for true cause and effect relationship." To emphasize these points and to guide pupils in problem solving, questions were used that required pupils to "recall past experiences, form an hypothesis, make a workable plan, search for facts, and weigh evidence with respect to pertinence, soundness, and adequacy" and consider cause and effect relationships.

The direct attack on superstitions was made by trying out particular superstitions in the classroom, such as *walking under a ladder will bring bad luck*. For some time after such an experience with a superstition, pupils reported in class all unpleasant things for which no good explanation could be given. After several weeks, conclusions were made by pupils as to the truth of this common superstition. At the close of the semester, 285 ninth grade pupils who had spent two hours each week following the special method of instruction were retested with Muller and Lundeen superstition test, Zapf superstition test, and Woodworth Mathews Personal Data Sheet.

To find the effect of science instruction without emphasis on superstitions, the scores of 546 pupils who had taken the Muller and Lundeen superstition test were grouped according to the number of semesters of general science they had had previous to the experiment. The averages of the scores of each group were determined.

The conclusions derived from this study are summarized as follows:

Regular general science work seemed to have no effect in reducing superstitious beliefs.

Superstitious responses were definitely reduced following a period of instruction directed toward this end.

There was a greater decrease in superstitious responses on the Zapf test than on the Muller and Lundeen test indicating probably that children find it easier to cease saying that a superstition is true than to cease feeling the influence of it.

Evidence indicates that the majority of children do not seem to be consistent in their superstitious beliefs.

The true scores of superstitious beliefs were found to correlate positively with emotional maladjustment.

A slight decrease in the mean, median, and 25 and 75 percentiles were found on the emotional adjustment scores following the period of special work. —F.G.B.

Embree, Royal B., and Floyd, Oliver R. "The Predictive Value of General Science." *Journal of Educational Research* 31: 650–655; May, 1938.

The emphasis that has been placed upon the guidance function of general science and other subjects in the junior high school makes this investigation an important one. It is concerned with achievement in general science as a means of predicting the probable success or failure of pupils in other science courses in the school. It grew out of an earlier study made by Floyd in which he found "little evidence that the ninth grade science course contributed to superior achievement in biology, chemistry or physics."

Records were studied of pupils who took science courses in the University of Minnesota High School during the years 1926–1933. During these years the offerings in science in this school were general science in ninth grade, biology in tenth grade, and physics and chemistry open to eleventh and twelfth grades.

The results show that general science as presented in the University of Minnesota High School "cannot be justified upon the basis of its predictive value." The authors suggest that general science "may make important contributions to the curriculum of the secondary school in other ways" than by contributing to superior achievement or predicting probable success or failure in biology, chemistry or physics.

—F.G.B.

SECONDARY SCIENCE

Stone, Charles H. "Some Modern Methods for Teaching Science." *School Science and Mathematics* 38: 146–162, February, 1938.

This article presents a number of practical illustrations of teaching devices to stimulate the interests of pupils and to present effectively various materials of physical science. —F.D.C.

Dresden, Arnold. "Methods of Thinking that Should Grow Out of the Study of Science and Mathematics." *Progressive Education* 15: 294–296; April, 1938.

The author considers scientific procedure in relation to science and mathematics under three headings: observation, recording, and drawing

conclusions. He discusses observation with unaided senses and by use of instruments. For recording observations measuring methods are necessary. They make it possible to see meaning in a group of observations, to draw conclusions, and make predictions from relationships expressed in records.

The method of thinking that involves observation, recording, and drawing conclusions makes possible the discovery of relationships, trends, and tendencies that are valuable in science and mathematics and in other fields as well.

—F.G.B.

WALKER, D. IRVINE. "Calculations in High School Chemistry." *Journal of Chemical Education* 14: 282–284; June, 1937.

The author presents in outline form the essential steps in solving the common types of chemical calculations in the high school course. This has been used in mimeographed form with pupils and found helpful. —V.H.N.

HASKINS, RICHARD, GAVIN, JOHN, AND BOWMAN, E. C. "An Experiment in the Teaching of High-School Chemistry." *Journal Chemical Education* 14: 321–323; July, 1937.

The authors describe an attempt to make chemistry more interesting and less difficult for beginning students by organizing the work in a modified form of the unit plan and by placing large emphasis upon individual work and initiative. A sample unit is given to illustrate the form of organzation and procedure followed. It is believed that this method of instruction is economical of time and materials and that it results in greater development of power in planning, executing, and interpreting laboratory work than the conventional method does. —V.H.N.

HUNTRESS, ERNEST H. "Daily Chemical Anniversaries as a Teaching Tool." *Journal Chemical Education* 14: 328–344; July, 1937.

A complete calendar giving names of chemists whose birth dates fall on each day of the year. Also gives the year of birth and date of death. The calendar is also cross referenced so that the men are named for whom a given day represents the date of death. —V.H.N.

"Report of the Committee on Minimum Equipment (For High School Chemistry)." *Journal Chemical Education* 14: 386–392; August, 1937.

This report includes all that is needed to meet the standard minimum high school course in chemistry as recommended by the American Chemical Society and the work included in the commonly used high school books. All equipment needed for individual experiments by eight pupils and demonstrations by the teacher is listed with prices, including both apparatus and materials. The report also has suggestions to the teacher of chemistry for laboratory procedure. —V.H.N.

GRAY, WILLIAM S. "The Preparation of Teachers of Chemistry." *Journal Chemical Education* 14: 466–471; October, 1937.

The training of teachers of high school chemistry like that of all teachers is affected greatly by changing social conditions. The efficient teacher must have social understanding and a social point of view as well as a thorough understanding of the nature of the world in which we live. He must, therefore, have first of all a good general education. Second, he needs adequate specialization in the field in which he is to teach. Third, he must be well equipped by professional training to perform his work efficiently in the broad sense of the term. —V.H.N.

CURRIER, A. J. "The Science Teacher's Job. *Journal Chemical Education* 14: 583–586; December, 1937.

The great increase in scientific knowledge, the growth in enrollment in secondary schools, and recent social and economic changes have all had a profound effect on the job of teaching science. There is increasing effort to make science teaching pedagogical as well as logical and scientific. —V.H.N.

ROSS, VERNE R. "Research Problems for Secondary School Pupils." *Journal Chemical Education* 15: 84–86; February, 1938.

Five case studies are reported of high school pupils whose interest in research was aroused following a course in high school chemistry. All carried out respectable research problems to successful conclusion. Several went on to graduate work in chemistry and university teaching. —V.H.N.

CURTIS, WILLIAM C. "A Brief Course in Commercial Chemistry for High School Students." *Journal Chemical Education* 15: 121–123; March, 1938.

This article gives suggestions and ideas for a course in chemistry to be given to those who have had a year of general high school chemistry and are not going on to college. —V.H.N.

HENDRICKS, B. CLIFFORD, AND FRUTCHEY, F. P. "The Uses of Examinations." *Journal Chemical Education* 15: 237–240; May, 1938.

This is a helpful discussion of the uses of tests and examinations. Fundamentally, they should be used to study the pupil and as a result of such study to help him to realize more completely his potentialities for growth and improvement. —V.H.N.

CLARK, PAUL E. "The Effect of High School Chemistry on Achievement in Beginning College Chemistry." *Journal Chemical Education* 15: 285–289; June, 1938.

Two experiments are reported comparing the achievement of students in college chemistry who had chemistry in high school with that of students who had no high school course in chemistry. In one experiment, semester grades are

used as the measure of achievement, in the other percentile ranks on the Iowa Placement Tests in Chemistry are used. In all cases, the measurement of achievement is restricted to the first semester's work. Those who had chemistry in high school do consistently better. —V.H.N.

ANONYMOUS. "Physical Environment and Its Effect on Human Beings." *The Science Leaflet* 11:26–32; March 17, 1938.

The following factors have affected living organisms: (1) oscillations of climate, (2) water, (3) the atmosphere, (4) the soil, (5) temperature, (6) radiation, (7) other vibrations, and (8) time. —C.M.P.

MEISTER, MORRIS. "The Greatest Hobby of Them All." *The Science Classroom* 17:1, 4; January, 1938.

This "greatest hobby" is the hooking of a camera to a microscope, the technique of which is described in this article. —C.M.P.

MEISTER, MORRIS. "Simple Apparatus for the Physiography Teacher." *The Science Classroom* 17:1, 4; March, 1938.

Demonstrations described: (1) mountain formation, (2) lava formation, and (3) volcanic mountain formation. —C.M.P.

MEISTER, MORRIS. "From the Classrooms of Successful Science." *The Science Classroom* 17:1; April, and May, 1938.

Interesting experiments described include: (1) projecting light beams on the blackboard; (2) capillary action, (3) making an opaque projector, (4) adjusting a "vial" Cartesian Diver, (5) an "assemble-able" bell, and (6) a transformer using the assembly technique. —C.M.P.

HOWARD, RUSSEL S. "Reorganization of Physical Science Course." *The Iowa Science Teacher* 5:6–7, 16; April, 1938.

This is a committee report which in brief recommends that a combination physical science course be offered those high school students who are unable to carry successfully the regular high school courses in physics and chemistry. This combination physical science course should not displace the present differentiated special science courses. The committee also believes that the present general science courses should be placed down in the elementary grades. —C.M.P.

WAILES, RAYMOND B. "Color Chemistry." *Popular Science Monthly* 132:90–91, 125; April, 1938.

Colors help identify unknown substances. Several interesting color changes obtained from chemical changes used in identifying certain substances are described. —C.M.P.

WAILES, RAYMOND B. "Fun with Magnetic Chemicals." *Popular Science Monthly* 132:96–97, 129–130; April, 1938.

This article describes some experiments with materials not commonly considered magnetic. —C.M.P.

RICHARDS, OSCAR W. "Photomicrography." *Biology Briefs* 1:25–29; April, 1938.

This is an excellent illustrated article describing the techniques involved in photographing microscopic life. —C.M.P.

WALLING, MORTON C. "Tissue—Thin Specimens Made for Your Microscope." *Popular Science Monthly* 132:86–87, 112–114; June, 1938.

This illustrated article describes an easy method by which soft substances can be sliced into sections by setting them in paraffin. —C.M.P.

WAILES, RAYMOND B. "Make It Yourself." *Popular Science Monthly* 132:88–89, 115–116; June, 1938.

Useful household chemicals that can be prepared in home laboratories are described. These include: ink for marking laundry, automatic siphon, rust stain removers, polishing cloth for removing tarnish, and so on. —C.M.P.

New Publications

Shoemaker, Lois Meier, and Shoemaker, Morris B. *The Conservation of Trees and Forests.* Trenton, N. J.: Department of Public Instruction, 1938. 16 p.

This is a manual for teachers prepared for use during the seventh annual New Jersey Conservation Week. Teachers in states other than New Jersey will find this manual just as useful as New Jersey teachers. The value of trees and forests, and how they may be conserved and protected is discussed. A useful bibliography for classroom use is included. —C.M.P.

Haupt, George W. *An Experimental Application of a Philosophy of Science Teaching in an Elementary School.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 109 p. $1.50.

From consideration of issues relating to content and methods used in teaching science in elementary schools, the author concludes that "these various points of view have become crystallized into two distinct philosophies of science instruction for children. On the one hand, there is the proposal that experiences should be provided which permit of interpretation and explanation contributory to an understanding of 'large generalizations.' . . . On the other hand, there is the assumption that young children are not capable of the kind of mental activity necessitated by the 'large generalization' type of aim and that therefore their experiences should consist mainly of observations."

This study was made to secure experimental data relating to the assumption made by the "generalization" type of philosophy, that is, that the application of this philosophy necessitates particular kinds of mental processes, that young children are capable of these mental processes, and that a practical continuous gradation of content can be effected. As a basis for this experimental study, the objective—*Green plants convert energy of light into energy of food and fuel—was studied.*

The results of the experimental teaching present evidence that children on each grade level generalize in terms of their experiences—the generalizations on lower levels differing from those on higher levels by being less complex. The data also show how an objective makes possible "elements of learning for presentation throughout a range of grade levels."

This study presents the first experimental data showing how the "generalization" type of philosophy may function in developing a continuous integrated science program in elementary schools. —F.G.B.

Beauchamp, Wilbur L., and West, Joe Young. *Curriculum Foundation Series. Science for Children.* Chicago: Scott, Foresman and Company, 1935. 144 p. Free to those who use *Science Stories.*

This book is written to aid teachers who use *Science Stories,* Books 1, 2, and 3, of the Curriculum Foundation Series and should be invaluable to them. It considers the following topics: objectives of science in primary grades; activities for children in the first semester of the first grade; steps in lesson planning; and teaching procedures for book one and two of the series. In the appendix, there is given a discussion of topics, such as the field trip, bird feeding stations and houses, insect cages, gardening, how to set up aquariums and terrariums, and the care of pets in the classroom. —F.G.B.

Beauchamp, Wilbur L., Fogg, Harriet M., Crampton, Gertrude, and Gray, William S. *Curriculum Foundation Series. Science Stories. Book 2.* Chicago: Scott, Foresman and Company, 1935. 176 p.

This is the second book of the *Curriculum Foundation Series.* The carefully selected subject materials are organized around scientific ideas that are important for the child in understanding many common things about him. Attention is directed toward accurate observation, performing experiments, and drawing conclusions all of which are inherent in the scientific method of work. The book is written in such a way that the young reader will gain interest in and an awareness and greater understanding of his environment. Special attention has been given to vocabulary and techniques of reading. The book is beautifully illustrated by appealing and appropriate photographs and drawings in color and by diagrams that are intimately tied up with content.

This is an excellent book for young readers. —F.G.B.

Beauchamp, Wilbur L., Fogg, Harriet M., Crampton, Gertrude, and Gray, William S. *Curriculum Foundation Series. Science Stories. Book 3.* Chicago: Scott, Foresman and Company, 1936. 256 p. $.76.

This is a delightful book in science for children on the third grade level. It is written in such a way that pupils will derive a growing interest and understanding of the science world in which they live. The concepts and experiences included have been found through experimental study to be within the interest and understanding of the third grade child. Special attention has been given to the development of vocabulary and to techniques of reading. The illustrations are

excellent and inherently tied up with reading materials. They include photographs in color and in black and white, drawings, diagrams, and maps. —F.G.B.

HUNTINGTON, ELLSWORTH. *Season of Birth, Its Relation to Human Abilities.* New York: John Wiley and Sons, Inc., 1938. 473 p. $3.50.

For several decades psychologists and others have suggested a relation between the time of year or season of birth and relative vitality and intelligence. Mr. Huntington has assembled a large amount of statistical records and has treated them under nineteen chapter headings. The data are from the United States, England, Belgium, France, Russia, Japan, with scattered reports from still other countries. The data are not always comparable since they were collected and tabulated by different persons, in different ways and for different purposes. However, the author is quite tentative in conclusions from such data. Indeed some readers will find it difficult to make their own or learn the author's inferences regarding many questions.

Obviously, the period or season of conception in given cases determines the period or season of birth. If, however, certain periods or seasons are unfavorable to the life or intelligence of children born at those times, it could be claimed that natural selection tends toward restriction of life and intelligence for persons conceived approximately nine months earlier. That is, if children born during early autumn are inferior in either intelligence or vitality, it might be inferred, that autumn is unfavorable; or that the preceding December, January and February are unfavorable conception periods; or that the intervening nine months' period is unfavorable for proper pre-natal development. However, when it is pointed out that any nine-month period is three-fourths of the whole year, the pre-natal development idea seems inconclusive.

Then, the author shows that the number of children surviving from a given period and their intelligence relative to births of another period do not always go together. In some countries it seems that the larger number of surviving children is associated with somewhat lower intelligence. On this point as on certain others the results suggest conflicting implications.

In some countries, both the number of births and relative intelligence appear to be closely related to climatic and industrial factors. For example, in Japan the summer period is peculiarly severe for working women. Small, close, and hot cooking and living rooms, work for long hours waist-deep in rice fields with heavy wet clothing, short sleeping hours, all combine to result in fewer summer conceptions and poorer quality in the resulting births. After October has come health improves and better births appear in the following June and July. Huntington shows, however, that there is an important natural history factor of control as well as the factors of climate and industry.

In general the author concludes that superior births occur in late winter and early spring months; and that important causes are the more favorable temperatures for conception in late spring and early summer; and that natural selection has operated through long periods to eliminate part of the young born at less favorable periods. —O.W.C.

DALY, REGINAL ALDWORTH. *The Changing World of the Ice Age.* New Haven: Yale University Press, 1935. 261 p. $5.00.

This is an excellent and thorough treatment of the problems of interpreting the phenomena of glaciation. It combines, in an unusual way, the generalized treatment which gives the layman an understanding of the problems involved, and the detailed and specific data needed by the specialist. The book considers in detail the changes in ocean volume due to the formation of ice caps, and their melting, and the results of the shifting weight of these large masses of water and ice on the plastic deformation of the continent. The logic of the organization of the material is remarkable. At every step it is made clear exactly what are observable facts, what assumptions are made, and comparative hypotheses are critically discussed. The first chapter discusses the evidence with regard to present and past ice-caps and the effect of the shifts of water from ocean to land in their formation. In order to elaborate upon this the author introduces a chapter dealing with present ideas as to earth structure and the mechanism of the earth's deformation and recoil under variation of crustal load. Then follows chapters on the change in sea level and interpretation, and a chapter on Coral Reefs and the Ice Age. While this is not exactly light reading the complexities of the problem have been presented so clearly and in such a well organized way that one with only a minor knowledge of geology will be given a remarkably comprehensive insight into the nature of the problems of glaciation, of the data which bear upon these problems and their interpretation, and of the present status of thought in regard to them. Data tables, maps and diagrams are unusually fine. The reviewer feels that through reading this book he has gained a unified picture of a phase of geology which heretofore had been comprehended only as a few bits of more or less unrelated information. —O. E. Underhill.

THE MONTHLY STAR FINDER. Observation Roofs, Rockefeller Center, 30 Rockefeller Plaza, New York, N. Y. 10 cents per copy, $1.00 a year.

The first page of this 8 page pamphlet contains a star map for the evening sky for the month. The back page contains a similar map for the early morning hours before sunrise. A complete sky chart giving right ascension and declination, based on the American Nautical Almanac chart, contains the detailed information for moon, sun and planets for the month. Short articles of

current interest about the planets and stars to be seen are given, and notes are given about the planets, double stars, nebulae, moon, and planetoids which may be observed. This should prove a very valuable aid to any group carrying on amateur star study. —O. E. Underhill.

CARPENTER, FRANCES. *Our Little Friends of China, Ah Hu and Ying HWA.* New York: American Book Company, 1937. 232 p.

This is one of a series of home-life readers for children, an excellent introduction to the study of geography. The daily activities through the four seasons of a boy and girl on a farm in central China form the basis for the story, and through their activities our school children learn of Chinese life on the farm and in a larger town and cities. Stories of folklore, changes brought about by modern progress, and strange customs of China are also given. Colored drawings make tasteful illustrations for the text. —L.M.S.

A New Development in Natural Science Pedagogy. Nature Magazine as a Current Text for Classroom Instruction in Natural Science. Washington: American Nature Association, 1936. 28 p.

This is a pamphlet on the use of Nature Magazine in the classroom, showing how its material can be adapted to various methods of teaching. Along with *Nature Magazine's Guide to Science Teaching,* teachers will find this material helpful in making fullest use of the rich offerings of Nature Magazine. —L.M.S.

ATKINSON, AGNES AKIN. *Perkey, a Biography of a Skunk.* New York: The Viking Press, 1937. 100 p. $1.50.

For ten years in the yard of their California home, Agnes and Spencer Atkinson have been putting out food for skunks, foxes, opossums, and ringtail cats.

Perkey is the story of a young skunk telling of his experiences at the feeding rock at the Man-House where he learns to be friends not only with the Man and Woman, but with the other animals which feed there.

Delightful photographs taken by the animals themselves illustrate the book. It is a charming story and one that would enhance interest in our native animals. —L.M.S.

ATKINSON, AGNES AKIN. *Skinny, The Gray Fox.* New York: The Viking Press, 1936. 111 p. $1.50.

This is a true story of the adventures of a gray fox. The story begins when Skinny was very young, before his eyes were open. At the early age of seven days, his family consisting of father, mother, and three cubs were driven by a great forest fire from their comfortable den in a dark warm cave. For a long distance the parents carried their young in their mouths. Finally with many other wild folk they found refuge in Eaton Canyon, Los Angeles National Forest, California.

Skinny grew up in the Canyon and learned to do many of the things that a fox must do in order to be successful in living and to develop into a wise and wary animal. After he had been "on his own" for some time, he found the home of Dr. and Mrs. Atkinson who regularly put food on flat rocks back of their house for wild animals that were brave enough to come for it. These kindly people were rewarded by daily visits from Skinny and the other wild animals that came to eat. They had opportunity to watch wild animals at close range, and were given pleasure in the satisfaction that comes in gaining confidence of wild folk.

The book is illustrated beautifully by seventeen photographs taken of Skinny and his companions. Children between the ages of eight and twelve years of age will enjoy this book which gives a new and delightful insight into the activities of a young wild fox and his associates. —F.G.B.

BUTLER, LORINE LETCHER. *Birds Around the Year.* New York: D. Appleton-Century Co., 1937. 242 p. $2.00.

In an attractive, fresh, lucid manner, the reader is introduced to the activities of common birds throughout the year. In each season—spring, summer, autumn, and winter—one is taken to fields, woods, parks, and gardens to enjoy birds as they return to their summer homes, go about their nest building, incubate their eggs, care for their young, and finally leave for their winter homes. While the book deals primarily with birds, the reader is given an intimate acquaintance with the procession of wild flowers as they blossom from early spring until late fall. One constantly feels the close familiarity of the author with birds and flowers which she has studied all through her life. The reader's enjoyment is enhanced by eight full page illustrations in black and white that are reproductions of paintings, drawings, and etchings by well known artists.

This book will be satisfying to students of junior-and-senior-high-school age, and adults alike. It should find place in every high-school library. —F.G.B.

PORTER, WALTER P., AND HANSEN, EINAR A. *The Pond Book.* New York: The American Book Company, 1936. 210 p. $.88.

This book emphasizes content in science designed as accurate supplementary reading material and as source materials for other subjects for children in the intermediate grades in elementary schools. The materials have been studied critically by three scientsts. The stories are about animals and plants that live in and around ponds, such as the giant waterbug, water strider, whirligig beetle, backswimmer, mosquito, caddisfly, dragonfly, crayfish, fairy shrimp, catfish, water snake, turtle, frog, toad, salamander, mudpuppy, kingfisher, heron, killdeer, redwing blackbird, pitcher plant, sundew, water lilies, cattails, and wild rice.

After each story is a list of things to do that are suggestive of ways interest can be extended by first hand experiences. The book is illustrated by appropriate photographs and drawings.
—F.G.B.

PORTER, WALTER P., AND HANSEN, EINAR A. *Fields and Fencerows.* New York: The American Book Company, 1937. 274 p. $.80.

This book like *The Pond Book* by the same authors emphasizes content in science as supplementary reading material and as source material for other subjects, for pupils in the intermediate grades in elementary schools. It deals with topics relating to ants, spiders, opossums, raccoons, skunks, bees, monkeys, grasshoppers, snakes, turtles, birds, trees, common spring flowers, ferns, seeds, cotton, hemp, wild fruit, bread mold, and mushrooms. The materials have been examined carefully by scientists for accuracy of statements.

At the close of each story is a list of things to do. The book is illustrated by many photographs that are intimately tied up with the content.
—F.G.B.

MANNIX, DANIEL P. *More Back-Yard Zoo.* New York: Coward-McCann, Inc., 1936. 252 p. $2.00.

This is a series of stories about animals written by a man who knows them and likes them. In the stories many interesting things are told about hawks used in falconry; "The Demon Rat" that turns out to be a mink; life in a tropical fish aquarium; Susie, a pet vulture; beavers in an unfrequented section of Canada; activities of a great horned owl; alligators on a farm in the southern part of the country; a pet parrot; rattlesnakes; centipedes; tarantulas; and many other animals.

These stories are refreshing and entertaining reading. They will be enjoyed by children of junior high school and secondary school age as well as by adults. Many excellent photographs add to the attractiveness of the book.
—F.G.B.

SUTTON, GEORGE MIKSCH. *Birds in the Wilderness. Adventures of an Ornithologist.* New York: The Macmillan Company, 1936. 200 p. $3.50.

This is a book that no lover of birds can afford to miss. It is written by a man who knows birds, who has lived with them and other wild folk all of his life, and who is an ornithologist and bird painter of note.

In an attractive and informal manner, the author tells of his exciting experiences with bluejays when a boy in Nebraska; of his adventures with road-runners and a turkey vulture in Texas; the pleasure derived from raising baby roadrunners; the joy of watching a pair of screech owls that made their home in an old apple tree in the yard of his West Virginia home; and the pride and thrill experienced when his half-tone illustrations used in the story of his pet roadrunners brought about the friendship and inspiration of Louis Agassiz Fuertes. The reader shares much of the thrill and excitement of the expedition to the breeding land of the blue goose on James Bay, Canada, and the finding of the wood ibis, swallow-tail kite, and man-of-war in their natural habitats in southern Florida. Then one is taken on an expedition to the west coast of Hudson Bay in the first successful search for the eggs of the Harris Sparrow.

In addition to telling the story of interesting adventures with birds, the reader is given some idea of the enthusiasm, patience, effort, and sacrifice involved in gaining information about the habits of birds and in securing museum specimens.

The book is illustrated beautifully by the author by twelve pencil drawings and field sketches in color made from living or freshly killed birds. The charming informal style makes the stories of experiences with birds and the adventures of the many excursions in forest, field, jungle, and tundra delightful reading for adults and young people in secondary schools. —F.G.B.

STRANG, RUTH. *An Introduction to Child Study.* New York: The Macmillan Company, 1938. 631 p. $3.00.

Those persons who found the first edition of the above title (1930) by Ruth Strang to be helpful, will be pleased with the wider range of material the author has brought into this revised (1938) edition. Her book is essentially "an applied psychology of childhood." Student groups in laboratory or observational study of children, as well as parents and teachers, should find this a very practical and helpful study. The study of child behavior begins with a look into hereditary influences and continues through successive stages into a study of the adolescent years. The physical, mental and social problems of children of respective stages are reviewed and studied in a light that will interest teachers particularly because these problems are so often related to the school-room. There is evidence of much research on the part of the author as well as a splendid utilization of some of the more recent investigations of others in allied fields.

There are many people who believe that much of the maladjustment to be found in adulthood today is attributable to a lack of sympathetic guidance through the earlier periods of life. It is to be hoped that books like this of Ruth Strang's will promote a greater extent of emotional stability in the years to come.
—Fred B. Bryant.

MONROE, WALTER S., AND ENGLEHART, MAX D. *The Scientific Study of Educational Problems.* New York: The Macmillan Company, 1936. 504 p. $3.00.

Research in the field of education is being improved rapidly by the continued study represented in some of the new books appearing in our libraries. The book by Monroe and Englehart is

one of the latest and most complete. It includes chapters on the definition of educational problems, collection of pertinent data, elementary techniques for handling such data, errors frequently made, studying the past in education, measuring instruments, survey techniques, experimentation, prediction, studying relationships, the philosophy of research, evaluation of research, and progress toward a science of education.

As a textbook for courses in educational research or as a reference book for research workers, this book will be distinctly helpful. Extensive bibliographies direct the reader to other sources of similar and supplementary information. —A.W.H.

BRONSTED, J. N. *Physical Chemistry.* New York: The Chemical Publishing Company, 1938. 394 p. $5.00.

A physical chemistry text by the man who formulated the proton theory of acids and bases should be of interest to all teachers of physical chemistry and those teachers of general chemistry who use the proton theory. The book has been available in Danish since 1936 but this is the first English edition. The author approaches physical chemistry from a thermodynamic standpoint and does an excellent job. There are several factors, however, which in the opinion of this reviewer prevent the book from being a good text for classroom use. The first is the lack of any information on the experimental side of physical chemistry. The second is the absence of the usual problem lists found in American texts. However, as a reference book this text cannot be too highly recommended. The Chemical Publishing Company are the exclusive agents in North and South America for this book.

—P. E. Hatfield.

BRINKLEY, STUART R. *Introductory General Chemistry.* New York: The Macmillan Company, 1938. 731 p. $3.50.

This is the revised edition of a text first published in 1932. It is a conventional general chemistry text in most respects. Each chapter is followed by a list of questions and in addition a set of 54 problems is included in the appendix. For the student majoring in chemistry the inclusion of somewhat more theoretical and less descriptive material might be helpful. The chapters on the metals are written with a view toward assisting the student in carrying out the qualitative separations which are usually introduced into second semester laboratory work. The usual tables are contained in the appendix. The line drawings in this book are excellent but some of the photographs are poor. —P. E. Hatfield.

MELDRUM, WILLIAM B., AND FLOSDORF, EARL W. *Qualitative Analysis of Inorganic Materials.* New York: American Book Company, 1938. 250 p. $2.50.

This text is intended for use in several types of qualitative courses. The material is arranged so that some of it may be omitted in the type of qualitative course taught in the second semester of general chemistry. Utilization of most of the material in the book makes it suitable for use in a one semester course in qualitative analysis.

The book is divided into three sections: Fundamental Principles, 83 pages; Laboratory Work, 115 pages; Appendix, 19 pages. The first section contains the theoretical material necessary for the complete understanding of the reactions involved in qualitative analysis. However, the ten problems and five questions at the end of this section hardly seem adequate. The second section contains preliminary experiments and methods for systematic analysis. The book makes no attempt to fall in with the present trend toward semi-micro analysis. The third section contains the usual apparatus and material lists for the course as well as solubility tables. A short bibliography is included.

—P. E. Hatfield.

CASWELL, ALBERT E. *An Outline of Physics.* New York: The Macmillan Company, 1938. 590 p. $3.75.

This book is a revision of an earlier edition. It is not intended for those planning to major in physics. In the words of the author, "Selection of material has been made with the fact in mind that most students will never take a more advanced course in the subject." The book is divided into the conventional units; Properties of Matter, Mechanics, Heat, Electricity and Magnetism, and Light and Sound. In addition a fifty-nine-page section on modern physics is included. Some of the best material in the book is included in this section. Most of the chapters are followed by problem lists. The answers to odd-numbered problems are included in the appendix. —P. E. Hatfield.

CURTMAN, LOUIS J. *Qualitative Chemical Analysis.* New York: The Macmillan Company, 1938. 514 p. $3.75.

This is the second edition of a very complete qualitative analysis text. The theoretical material in the book is very good, especially the use of the Bronsted concept of acids and bases. A large number of problems are included. In addition to the usual macro methods, a short section on semi-micro analysis has been included. The book is intended for use in either a one- or a two-semester course. —P. E. Hatfield.

SMART, W. M. *Astronomy.* New York: Oxford University Press, 1937. 158 p. $1.50.

This book is an excellent exposition on the fundamentals of the universe for the general reader and for supplementary reading in survey courses. It deals with the elements of the solar system, the history of planetary discoveries, how light travels through space, the origin of the nature of the stars and something of the depth and size of space.

It is easy reading and decidedly easy to inter-

pret. The author has made a distinct contribution for the general reader.

This book is one of the series being published by the Oxford University Press, with the general title, *The Pageant of Progress.* It should be accessible to students of all ages in every school library.

Although in some respects the point of view is different from that of American astronomers, it is not by any means radical. The author is a distinguished worker in his field and is highly respected by his contemporaries.

—E. C. Harrah.

SAYLES, LEONARD P. *Manual for Comparative Anatomy.* New York: The Macmillan Company, 1938. 214 p. $1.60.

In this book the author has compiled a large amount of information in a limited space. It is adaptable to many situations because a large number of types are included. The material is organized on the basis of the systems that make up the arrangement so that it can become truly comparative.

A teacher desiring comparative anatomy guides can select from this text the forms they are using and adapt them admirably to their own work.

For one semester courses in comparative anatomy, the book would be somewhat bulky and the student would find it necessary to turn through many pages to find the material desired.

The binding is of the ring type and lends itself admirably to laboratory usage because it lies open in the perfectly flat manner. The diagrams are well made and exceedingly clear. These will enable the students to carry their dissection through with little difficulty. In general the work will be a decided help to those who give courses in comparative anatomy.

—E. C. Harrah.

BRUNER, HENRY LANE. *Laboratory Directions in College Zoölogy.* New York: The Macmillan Company, 1938. 163 p. $1.75.

This book is a revised edition of the 1926 copyright by the same author. Minor changes have been made in various places and errors have been corrected.

For those who desire a laboratory manual for the traditional type of zoölogy course, this book is well fitted. It has directions for a large number of types and is suited for a complete year's work. However, by careful selection, one may reduce the length of time spent on it. It is best adapted to go with Hegner's *College Zoölogy.*

The author, Professor Bruner, and his associates have done an excellent job of preparing the manual for the traditional course.

—E. C. Harrah.

WALTER, HERBERT EUGENE. *Genetics.* New York: The Macmillan Company, 1938. 412 p. $3.00.

This book is intended for those interested in a textbook on genetics that can be interpreted by the uninitiated. The fourth edition of Walter's *Genetics* is a very desirable production. The author, again in a clear, interesting style, has brought up to date the recent information acquired by research workers and presented it in his usual understandable manner.

The addition of a series of problems that the student may practice in interpretation of problems in genetics is a decided help in its use.

The writer believes that this book should be available in every school library so that students who are interested in acquiring knowledge on heredity and eugenics will have available a readable text that is reliable. —E. C. Harrah.

ROSE, MARY SWARTZ. *Foundations of Nutrition.* New York: The Macmillan Company, 1938. 625 p. $3.50.

Those who are interested in a course in nutrition or in reference reading for courses in physiology with respect to metabolism will find *The Foundations of Nutrition* by Rose exceedingly good.

In the third edition Professor Rose has brought the book up to date with the addition of new material based on recent research. The sections that are notably enlarged and expanded are those on the vitamins and hormones. The addition of new illustrations has added materially to the value of the book.

In addition to the text material there is an appendix of admirable material concerning foods and their food value, with respect to mineral and vitamin content. This appendix also contains tables showing the amount and kinds of food needed by individuals of different ages and under different conditions of physiology.

The writer feels that there is no more valuable work on the market with reference to metabolism.

—E. C. Harrah.

HOLMAN, RICHARD M., AND ROBBINS, WILFRED W. *A Textbook of General Botany for Colleges and Universities.* New York: John Wiley and Sons, Inc., 1938. 664 p. $4.50.

In *A Textbook of General Botany,* the authors have again reached a climax in textbooks for botany. The fourth edition of Holman-Robbins has been enlarged in many sections in conformance with recent research in this field, especially the sections on absorption and conduction by roots, which has been almost entirely rewritten, and the section dealing with sap in stems in conduction of foods, which has been enlarged and modified. The theory of active solute absorption has been given more weight and a better interpretation.

The subject matter pertaining to the origin and development of life has been thoroughly revised, and the classifications of tissues have been materially changed. The authors have also included a discussion of the relation of hormones to growth phenomena, a field of study which is becoming more and more important in the field of botany.

This book again stands out distinctly in its field and, without doubt, will maintain a continued high reputation. —E. C. Harrah.

ANONYMOUS. *The Case for Freedom from Federal Control of Hours and Wages.* Chicago (221 N. La Salle Street): Machinery and Allied Products Institute, 1938. 21 p.

This is a pamphlet ably presenting the facts upon which are based the argument against federal regulation of wages and hours. It is maintained that our rapid economic and social progress, thus far achieved, has been due to freedom from control. A continuation of this freedom from control assures our further advance. A series of interesting graphs and charts are included. —C.M.P.

HOWATH, A. A. *The Soybean Industry.* New York: The Chemical Publishing Company, 1938. 221 p.

One of the most striking agricultural developments in the United States in recent times has been the rapid rise of the soybean. In 1907 there were 50,000 acres; in 1935, nearly 5,500,000. In 1920, seed production was 3,000,000 bushels; in 1935, about 40,000,000 bushels. Remarkable progress has been made in developing food and industrial uses for the soybean, the oil and meal. At present there are 45 oil mills; 40 concerns manufacturing soybean food products and soybean flour; and 75 factories are turning out various industrial products. In 1936 soybeans were first listed on the Chicago Board of Trade. The price per bushel is approximately that of wheat.

In this book Dr. Howath writes from many years of practical experience as an observer, research worker and practical technologist. Few, if any, Americans are so well-informed regarding soybeans. This book is an authoritative treatise, yet is not too highly technical for anyone desiring accurate information. Few plant products have a greater variety of uses.

You are probably eating soybeans in some form or other. The flour is being used in making bread, in wieners, frankfurters and bologna sausage. The oil is used in makiing mayonnaise and salad dressings. Soybean oil is also used in point, making synthetic resins, soap, waterproofing cement, codling moth control, artificial petroleum and so on. Plastics, and adhesive and sizing materials constitute important uses of soybean protein.

No wonder the Japanese wanted Manchuria because of the soybeans that are and can be raised there! —C.M.P.

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